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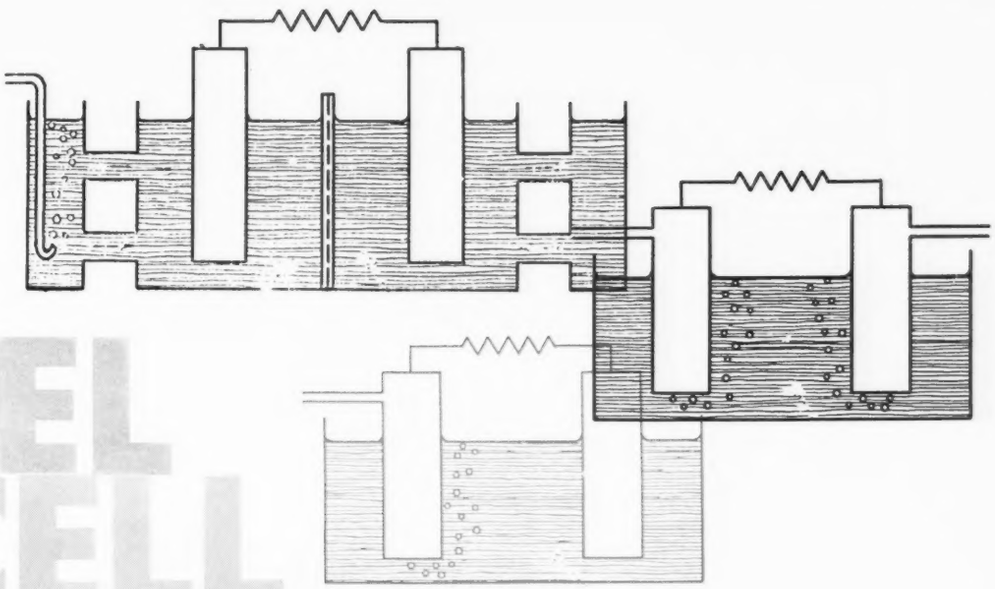
DEC 3 1959

DECEMBER 1959

American
Gas Journal
THE MAGAZINE OF GAS DISTRIBUTION



FUEL CELL RESEARCH

And Its Significance to the Gas Industry

"Gas Appliance Center" to Open in Dallas in January..... 28
Corrosion and Leakage Control Problems in Florida..... 30
Pictorial Review: "Tools for Tomorrow" at A.G.A. Exhibit.. 25

ADD LOADS . . . . . +
SUBTRACT COSTS . . . . . —
MULTIPLY PROFITS X

SIMPLE ARITHMETIC PROVES

WELDED STEELCASE METERS BEST

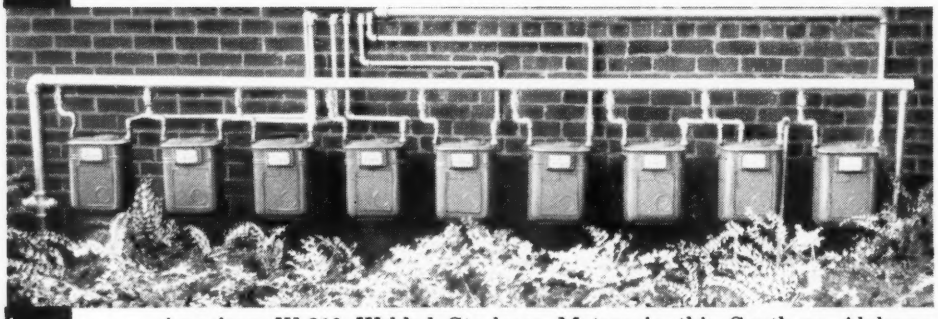
Modern American® Welded Steelcase Meters combine hardcase durability with proven tinned steelcase performance to provide a new approach to the economics of meter maintenance and retirement.

Low first costs – long-term maintenance savings. Major repairs eliminated – minor repairs and adjustments are easy to make assuring long service life.

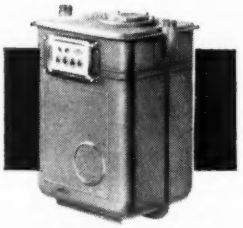
Lifetime weather and corrosion resistant finish stays attractive in both indoor and normal outdoor settings. Special impervious coating for highly corrosive atmospheres also available.

Sustained accuracy is built into these meters with proven speed ratio and the many time-tested quality features and refinements pioneered by American in more than 120 years of meter engineering.

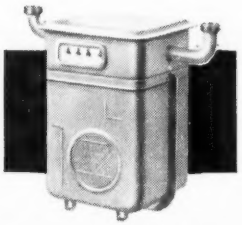
Ask your American representative about Welded Steelcase Meters and their many advantages for all fuel gas services.



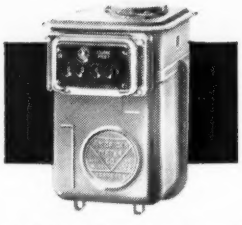
American W-210 Welded Steelcase Meters in this Southern Alabama installation insure dependable, accurate measurement and long-term outdoor service without rusting.



W-210 Welded Steelcase Meter
Rated capacity 210 cfh for medium-sized homes with heating.



W-75 Welded Steelcase Meter
Rated capacity 75 cfh for average homes without central heating.



W-45-LPG Welded Steelcase Meter
Rated capacity 45 cfh propane for average domestic services without heating.

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METER COMPANY
INCORPORATED (ESTABLISHED 1836)

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1859 1959
CENTENNIAL YEAR

American Gas Journal

ONLY MAGAZINE EDITED EXCLUSIVELY FOR THE GAS DISTRIBUTION INDUSTRY

Volume 186 December 1959 Number 13

DEAR READERS:

The Staff
of
American Gas Journal
Wishes
Each and Every One
of You
A
Very
MERRY
CHRISTMAS
and
a
PROSPEROUS
and
HAPPY
NEW YEAR

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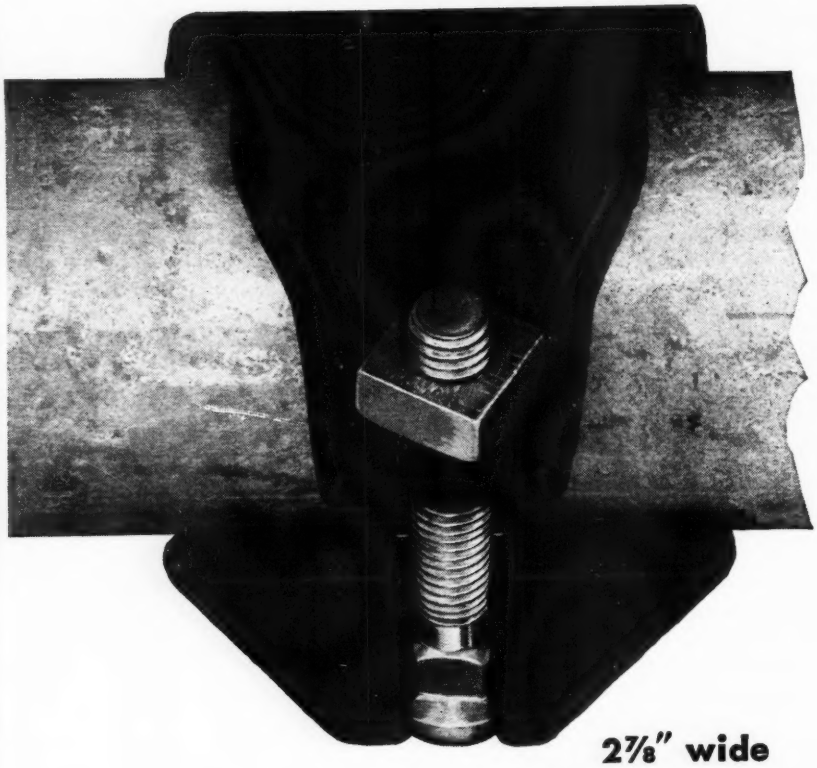
For speediest repair of corrosion leaks in pipe

JUNIOR EMERGENCY PIPE CLAMP

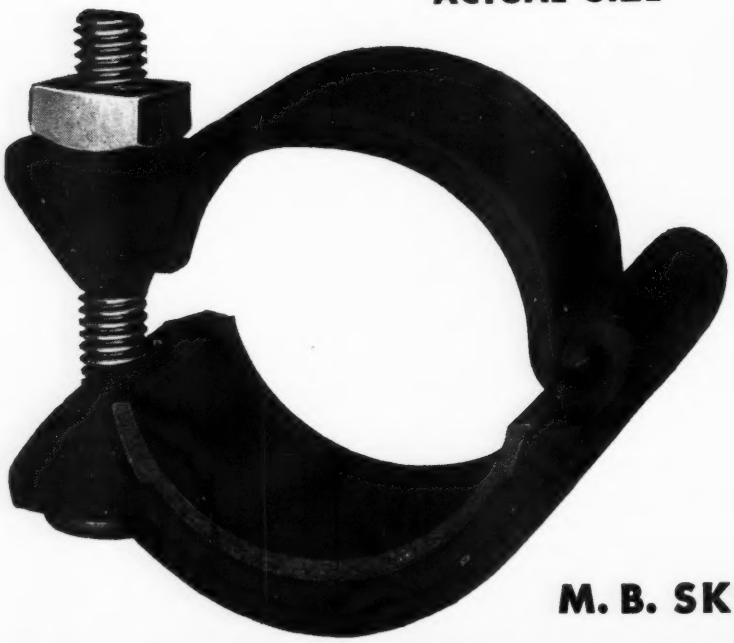


2⅞" wide
ACTUAL SIZE

Speediest application—slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full length hinge along one side. Formed to exact pipe size—no bending. The recessed pressure-equalizing gasket, entire width of clamp, is cemented in. A lasting installation.



Lug on gasket half is slotted

M. B. SKINNER CO., South Bend, Ind.

SKINNER-SEAL JUNIOR EMERGENCY PIPE CLAMP

AMERICAN GAS JOURNAL

1859 1959

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MCF

NEWS HILITES OF THE INDUSTRY

Midwestern Gas Transmission Company has received FPC authorization to import 204,000,000 cu ft of gas per day from Canada. Next step is to obtain approval from Canadian government agencies for the export of gas from Alberta gas fields by Trans-Canada Pipe Lines, Ltd.; point of delivery of the gas will be Emerson, Manitoba, on the U.S.-Canadian border. Applications by Trans-Canada are now pending before Province of Alberta and Canadian government agencies. Both are expected to approve the gas export. Canada's new National Energy Board, soon to become operative, may have to pass on the application if final action is not taken before it assumes control of exports of natural gas.

Midwestern will construct a 504-mile, 24-in. main line from the border to Marshfield, Wisconsin, plus 56 miles of laterals and two compressor stations, and will deliver 158,000,000 cu ft per day at Marshfield to Michigan Wisconsin Pipeline Company, along with sales enroute to Northern States Power Company, Montana-Dakota Utilities Company, United Petroleum Gas Company, and nine Minnesota communities.

Michigan Wisconsin will build 97 miles of 20 and 24-in. line from Marshfield to its existing system near Appleton, Wisconsin, plus a 96-mile, 16-in. extension to Menominee, Michigan, and 118 miles of lateral lines. Michigan Wisconsin will use the gas to serve seven new distribution company customers and increase deliveries to Michigan Gas and Electric Company. The seven new utilities to be served include Allerton (Iowa) Gas Company; Natural Gas Distributors, Inc. (Sparta, Wisconsin); Seymour (Iowa) Gas Company; Central Missouri Gas Company; Illinois Power Company; Iowa Southern Utilities, and New London (Iowa) Gas Company.

Santa Claus notwithstanding, "Christmas Trees" are under FPC jurisdiction. The Supreme Court has refused to review a circuit court of appeals decision that affirmed an FPC ruling that the "Christmas tree" assemblage on a gas well is a "sale" facility and, therefore, under FPC jurisdiction and can be certificated in an order to an independent natural gas producer. Continental Oil Company contended such facilities are wholly related to production and should not be included in certification even though the gas sale is "admittedly" under FPC jurisdiction.

How far can courts go in overruling FPC interpretations of contracts between "natural gas companies"? The Supreme Court has consented to define the power of judges in such cases, at the request of the FPC. Interpretation of rate contracts is the commissioner's job, says the FPC, and such interpretations — if reasonably supported by evidence — "must be accepted by the courts." If such principle is not firmly established, the result will be endless litigation, declares the FPC, and anyone dissatisfied with an FPC contract ruling will seek a new factual interpretation in the courts.

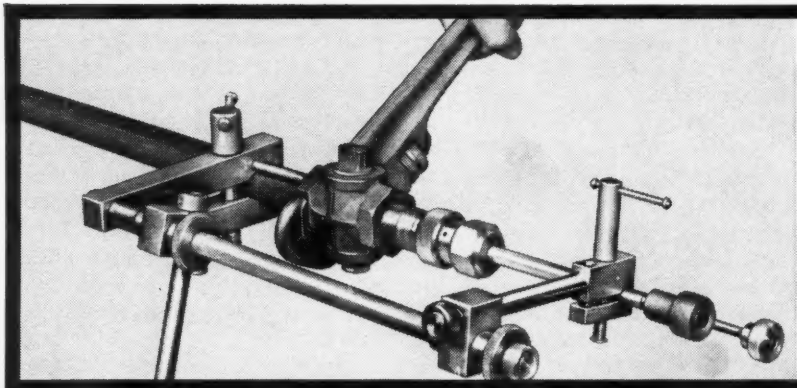
Much of the FPC's difficulty in this area undoubtedly stems from its seeming refusal to accept contracts that existed at the time (1954) it was told it had jurisdiction over independent natural gas producers. The commission has refused to recognize certain contractual conditions, such as "favored nation clauses" in contracts existing at that time, declaring such clauses applied only in "new contracts" signed by pipeline purchasers.

Construction on Transwestern Pipeline Company's Oklahoma-Texas to California line is underway and suppliers of gas to the new transmission firm have accepted "conditioned contracts" demanded by the FPC. The gas producers and the FPC will soon enter into a round of hearings on rates, which the commission agreed to do if the producers accepted the conditional contracts.

AMERICAN GAS JOURNAL, December 1959, Vol. 186, No. 13. Published monthly except August, then semi-monthly by The Petroleum Engineer Publishing Company, P. O. Box 1589, Dallas, Texas. Second class mail privileges authorized at Dallas, Texas. Executive and Editorial Offices at 800 Davis Building, P. O. Box 1589, Dallas 21, Texas.

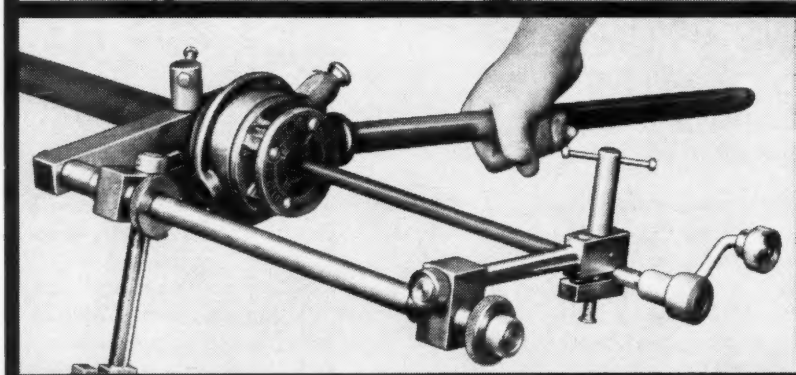
replace gas stops... safely under pressure!

New! MUELLER® *Model #2 No-Blo Stop Changer*



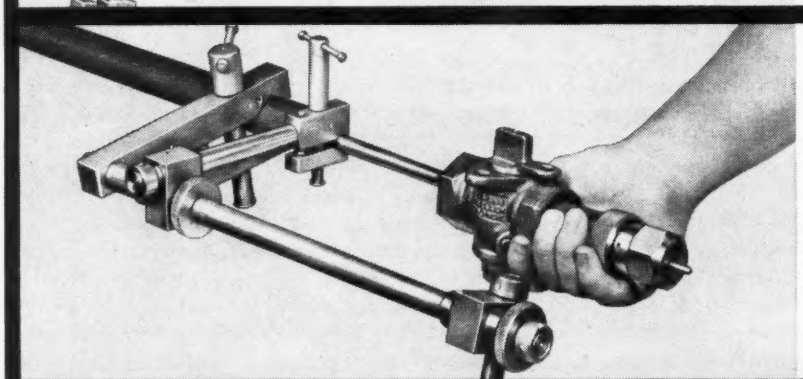
Remove old stop!

Greater swing clearance of this new model permits its use with a wider variety of stops — even lubricated plug valves and gate valves!



Cut-off and rethread pipe!

Greater length of both the safety clamp and the plugging units of Model #2 permits damaged threads to be cut-off and the pipe to be rethreaded before installing the new stop.



Install new stop!

New stops may be installed quickly under pressures up to 60 p.s.i. without bucking line pressure and with no blowing of gas.

This new model of the H-17010 Stop Changer makes Mueller's exclusive No-Blo method for replacing obsolete or damaged gas stops under pressure **even more versatile than before!** It is typical of the constant attention to detail in research, design and engineering that becomes a part of all Mueller No-Blo products manufactured for the gas industry. Write for complete information today.

NO-BLO®

GEM Sponsor GAC Z-mac Rubber

MUELLER CO. Since 1857 SERVING the Water and Gas Industries QUALITY

MUELLER CO.
DECATUR, ILL.

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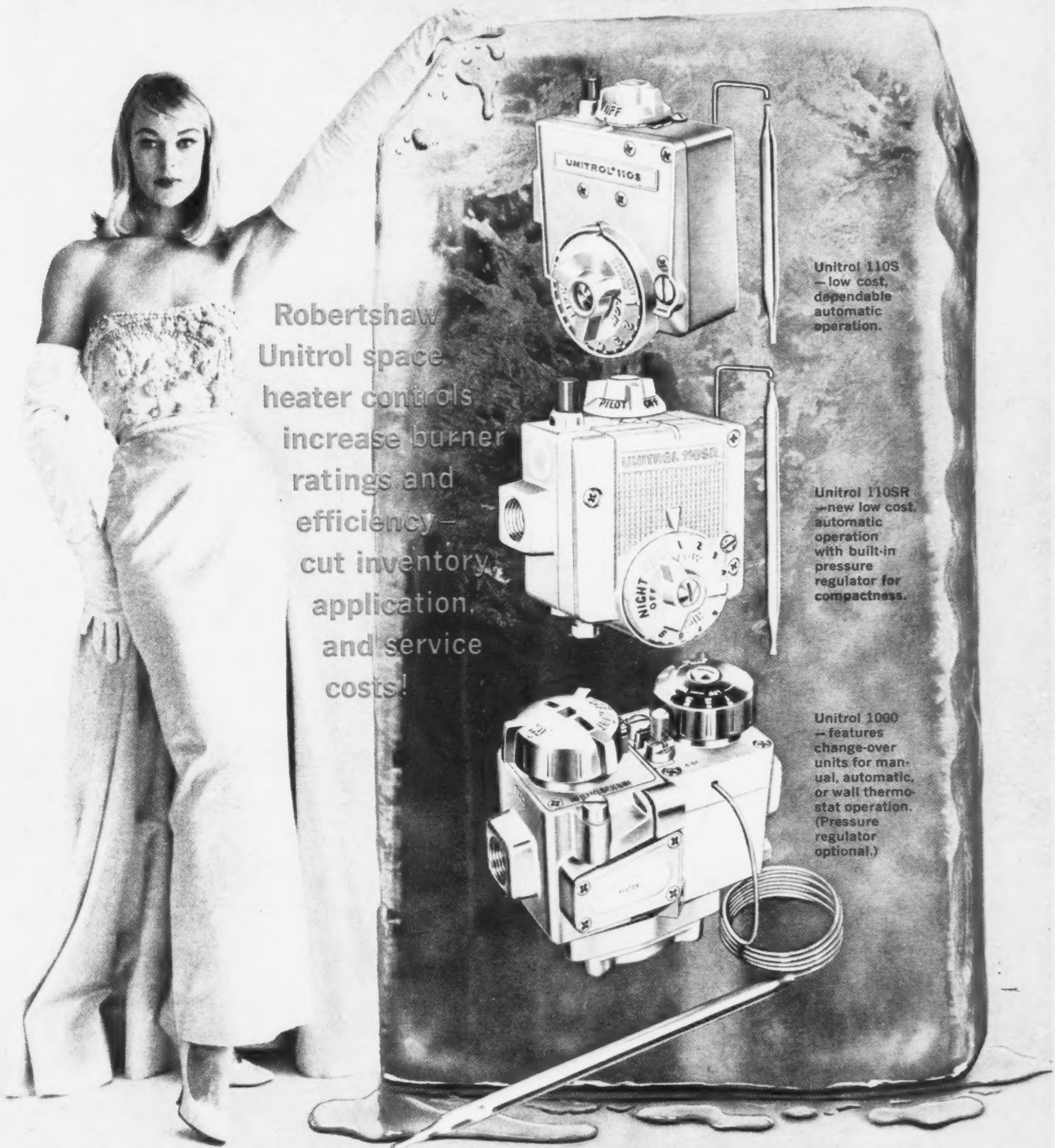
thaw extra profits out of ROBERTSHAW dependability!


UNITROL® 110S
OFF
PILOT
NIGHT
OFF
Robertshaw Unitrol space heater controls increase burner ratings and efficiency — cut inventory, application, and service costs!
Unitrol 110S — low cost, dependable automatic operation.
Unitrol 110SR — new low cost, automatic operation with built-in pressure regulator for compactness.
Unitrol 1000 — features change-over units for manual, automatic, or wall thermostat operation. (Pressure regulator optional.)

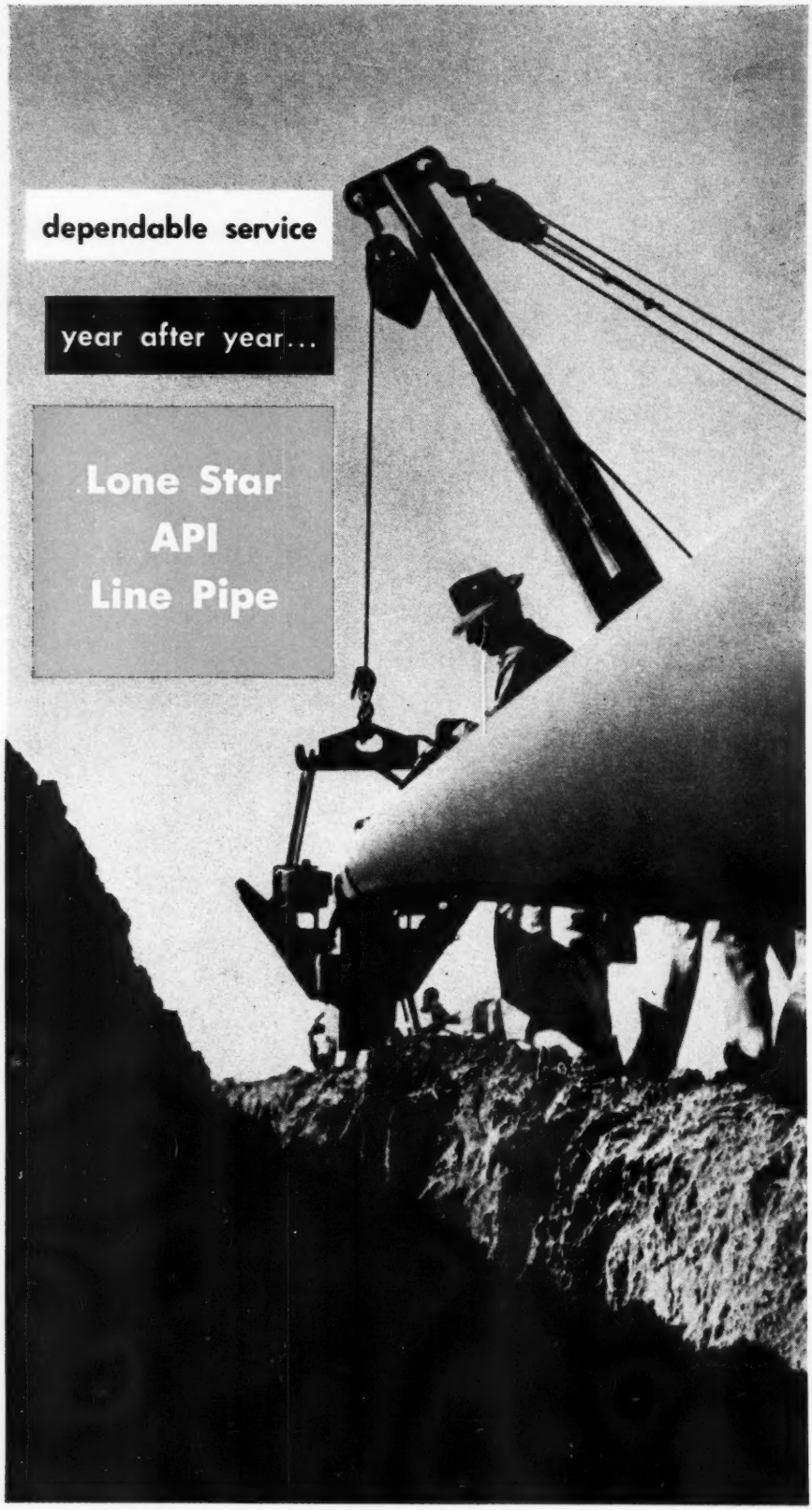
The surest way to thaw extra profit out of space heater appliances is to specify controls that operate dependably to safeguard your product reputation and cut service costs. The Robertshaw Unitrol 110S provides dependable, low cost return air sensing element operation. The new Unitrol 110SR combines the economy and dependability of the 110S with the increased burner efficiency provided by a built-in pressure regulator—*plus compactness!* The Unitrol 1000 provides inventory-saving change-over units for manual, automatic, and wall thermostat operation.

Inquire today . . . contact

Robertshaw

CONTROLS COMPANY

GRAYSON CONTROLS DIVISION, LONG BEACH, CALIF.



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COMING EVENTS IN THE GAS DISTRIBUTION INDUSTRY

December

7-11 NACE-University of Illinois Corrosion Control Short Course, Urbana Campus, Urbana, Illinois.

January 1960

20 NEGA, operating division, Sheraton Plaza, Boston, Massachusetts.

22 Oklahoma Utilities Association, accounting section, Tulsa, Oklahoma.

28 NEGA, accounting division, Statler Hilton, Boston, Massachusetts.

February 1960

1- 4 American Society of Heating Refrigerating & Air Conditioning Engineers, semi-annual meeting, Memorial Auditorium, Dallas, Texas.

1- 5 ISA instrument-automation conference, Houston, Texas.

29-Mar. 2 A.G.A. general management section conference, Pittsburgh-Hilton Hotel, Pittsburgh, Pennsylvania.

March 1960

14-18 National Association of Corrosion Engineers, annual convention, Dallas, Texas.

21-23 Mid-West Gas Association, annual meeting and convention, Hotel St. Paul, St. Paul, Minnesota.

23 Oklahoma Utilities Association, accounting section, Biltmore Hotel, Oklahoma City, Oklahoma.

24-25 Oklahoma Utilities Association, annual convention, Biltmore Hotel, Oklahoma City, Oklahoma.

24-25 NEGA annual meeting, Hotel Statler, Boston, Massachusetts.

30-April 1 GAMA annual meeting, The Greenbrier, White Sulphur Springs, West Virginia.

April 1960

5- 7 A.G.A. sales conference on industrial and commercial gas, The Shamrock Hilton, Houston, Texas.

8-9 Florida-Georgia Gas Association, annual convention, Biltmore Hotel, Palm Beach, Florida.

19-21 Southwestern Gas Measurement Short Course, University of Oklahoma, North Campus, Norman, Oklahoma.

19-21 A.G.A. Research & Utilization Conference, Hotel Carter, Cleveland, Ohio.

21-22 Indiana Gas Association, French Lick-Sheraton Hotel, French Lick, Indiana.

25-27 A.G.A.-EEI National Conference of Electric and Gas Utility Accountants, Roosevelt & Commodore hotels, New York City.

25-27 Southern Gas Association, annual convention, Galveston, Texas.

27-29 NACE Portland Section Corrosion Control Short Course, Portland, Ore.

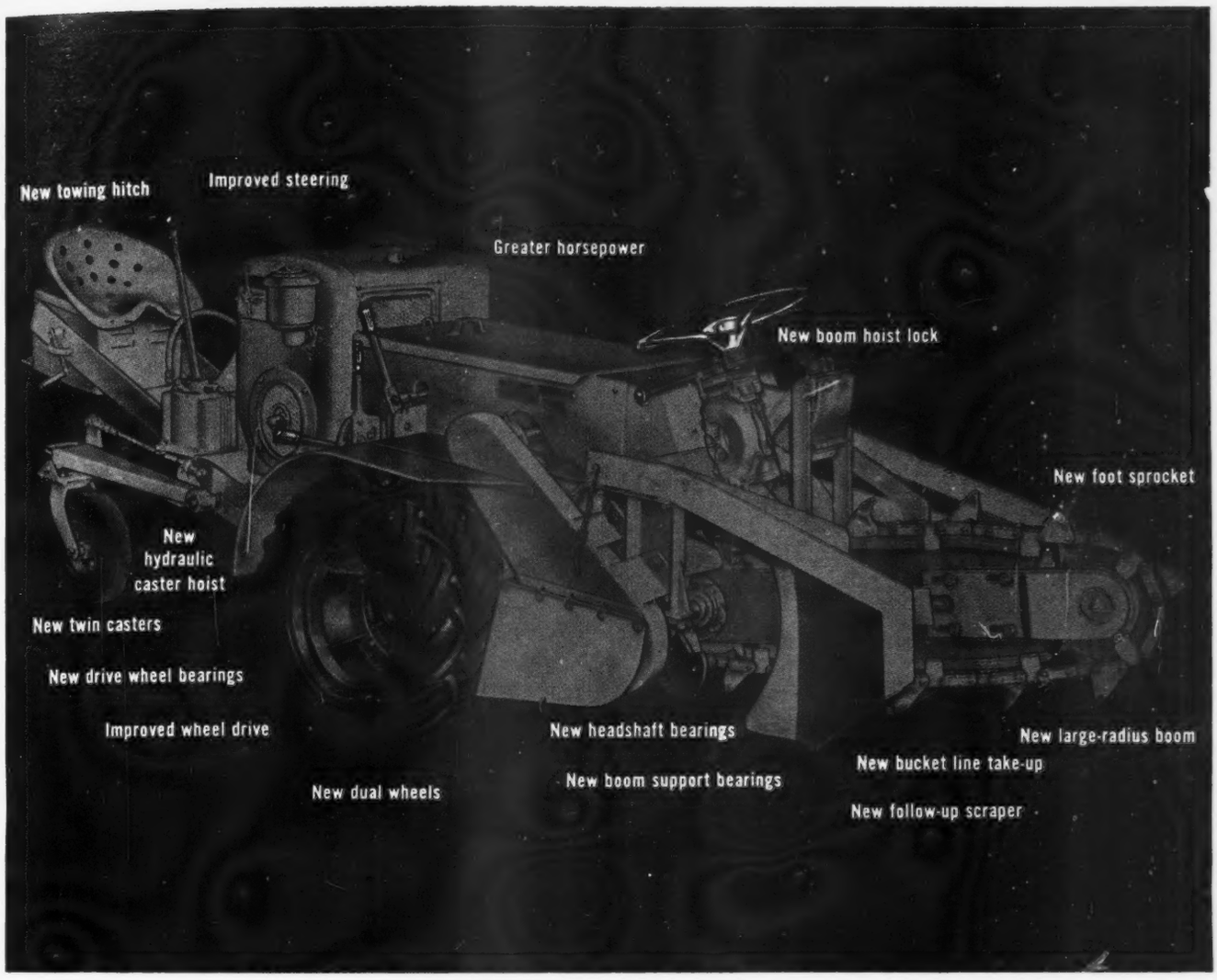
May 1960

9-12 National Restaurant Show, Navy Pier, Chicago, Illinois.

9-13 ISA instrument-automation conference, San Francisco, California.

9-13 A.G.A. operating section, joint distribution and transmission conference, Hotels Roosevelt and Jung, New Orleans, Louisiana.

12-13 A.G.A. eastern gas sales conference, Statler Hotel, Washington, D. C.



No other ditcher equals the new 702-A for electrical, plumbing and excavating contractors, railroads, utilities, telephone companies, and government bodies. Write for literature.

Easier operation, reduced maintenance, greater maneuverability with

New Barber-Greene 702-A Ditcher

New cost and performance records for underground placement of gas, water, electric and telephone services, sprinkler systems, and all other work requiring narrow trenches were set by the Barber-Greene Model 702 Ditcher. The new Model 702-A offers even faster, more economical digging.

Maintenance costs are reduced by new headshaft bearings, new boom support bearings, new large-radius foot end, and optional foot sprocket. New positive boom hoist lock.

Greater horsepower and new reduced bucket line speed allow digging through tougher materials. New hydraulic caster hoist makes height adjustment easier, more accurate. Optional dual wheels allow machine to operate on unstable bases. Optional electric starter.

The 300% more brake area and improved lever action make steering easier, more accurate. Optional follow-up scraper assures clean trench. New bucket line take-up is readily accessible.

Faster towing with new tapered roller wheel bearings and improved towing hitch. Optional twin casters give better stability and steering, and allow machine to straddle trench.

58-43-D

Write for information on the newest ditcher in the line of advanced design.

Representatives in Principal Cities of the World

Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.

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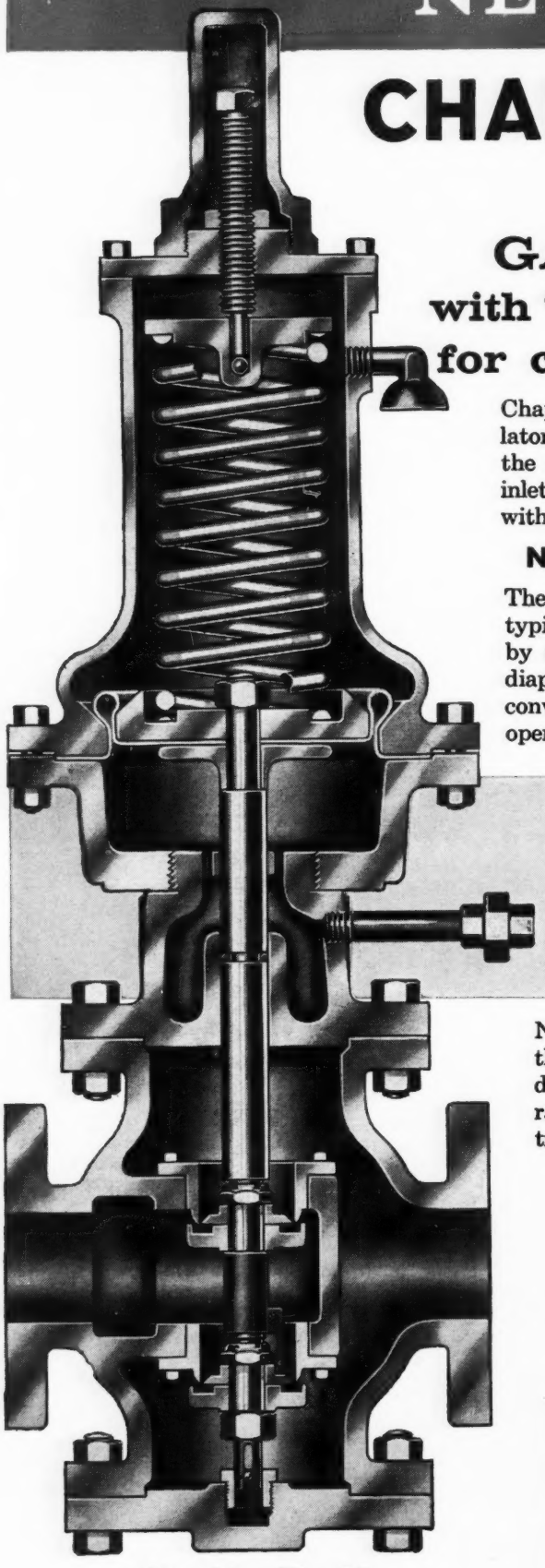
CONVEYORS...LOADERS...DITCHERS...ASPHALT PAVING EQUIPMENT

NEW IN PRINCIPLE! NEW IN DESIGN!



2" - 3" - 4" - 6"

Write for Bulletin 57-S

CHAPLIN-FULTON

Model 57-S

GAS REGULATOR

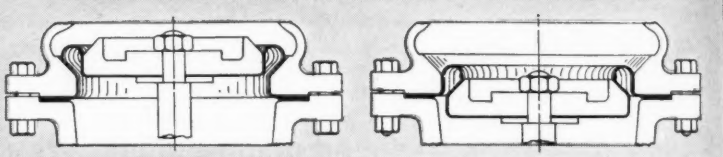
with "ROLL-OUT" Diaphragm for constant pressure control

Chaplin-Fulton Model 57-S is a simple spring loaded regulator which performs like a pilot loaded regulator, without the added complications. For pounds-to-pounds service—inlet pressures to 400 psi—controlled pressures to 75 psi, with deviation through full valve travel less than 1 psi.

NO "FALL-OFF" AS FLOW INCREASES

The drooping characteristics or outlet pressure "fall-off", typical of conventional spring regulators, is eliminated—not by using an uncontrollable velocity effect—but by a new diaphragm design which actually reverses the action of a conventional diaphragm. It changes its area as the valve opens to compensate for the loss in spring loading force.

"ROLL-OUT" DIAPHRAGM PRINCIPLE



VALVE CLOSED VALVE OPEN

Note how, with the valve upwards in the closed position, the diaphragm achieves its maximum effective area—and decreases as the valve opens. The area changes at the same rate as the spring loses compression, to give a constant controlled pressure—determined entirely by valve movement.

ACCURATE CF MFG. CO. DEPENDABLE

Chaplin-Fulton

MANUFACTURING COMPANY

Pittsburgh 25, Pennsylvania

NEWSREEL

NATURAL GAS FOR BOILER FUEL has been given an "okay" by the U. S. Third Circuit Court of Appeals, which set aside an FPC order denying Transcontinental Gas Pipe Line Corporation permission to transport natural gas from Texas to New York for Consolidated Edison Company of New York. The court ruled that the FPC overstepped its authority by objecting to the use of the gas to fire boilers. The FPC contended that such usage was waste of a valuable natural resource. The court said it could see no difference between homes heated by gas-fired boilers and apartment houses heated by steam purchased from Con Ed if such steam came from Con Ed's gas-fired boilers.

COLORADO INTERSTATE GAS COMPANY has reached a final settlement with its wholesale customers, that settles rates for the years 1958 and 1959 and establishes rates for the future. The agreement means that, for the first time since January 1954, CIG's rates are not subject to dispute by its customers or any regulatory agencies. Final rates agreed upon will mean a reduction of approximately 17 percent in rates presently being collected by Interstate from its wholesale customers and a refund by CIG of approximately $11,800,000 including interest in settlement of rates for 1958 and the first 10 months of 1959. Under the agreement, rates established for 1959 are subject to a further refund by CIG of any revenues in excess of a 6 percent rate of return on investment. Wholesale customers affected include Public Service Co. of Colorado, Colorado-Wyoming Gas Co., City of Colorado Springs, Pueblo Gas and Fuel Co., Citizens Utilities Co., Plateau Natural Gas Co., Greeley Gas Co., City of Trinidad, Kansas-Colorado Utilities, Inc., and Eastern Colorado Utility Co.

FARMING WITH GAS HELPS PIONEER — Unlike most natural gas utility companies who cut back on their gas supply purchases during the hot summer months, Pioneer Natural Gas Company, Amarillo, Texas, has continued to set new records. No longer dependent on the heavy winter heating load for the bulk of its consumer sales, Pioneer reached an all-time peak sendout August 5, supplying 310,000,000 cu ft of natural gas for the West Texas division during the 24-hour period. Previous record, also reached during the summer, was 241,000,000 cu ft in August 1958. Highest winter record load is 208,691,000 cu ft, reached in January, 1959. Pioneer officials attribute the unusually high summertime load to the increasingly large number of natural gas powered irrigation wells throughout the Panhandle and West Texas areas. Over 22,000 farmers throughout Pioneer's area are now "farming with gas."

CINCINNATI TO TURN OUT ITS GAS LIGHTS — City utility director George Howie has recommended that the city replace some 475 gas street lights on 63 streets, to "aid traffic safety." Studies, he said, indicate all 63 streets have traffic loads of 600 or more vehicles daily. The lights up until now have been kept because "residents liked them."

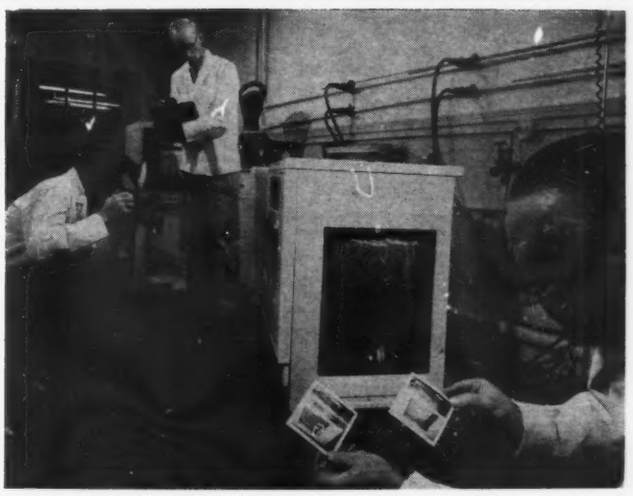
CASCADE NATURAL GAS CORPORATION is expanding its operations. The Seattle, Washington, utility has acquired by merger Eastern Oregon Natural Gas Company of Ontario, Oregon, and Consumers Gas Company of Bend, Oregon. Eastern Oregon serves the towns of Ontario, Nyssas, Milton-Freewater and Hermiston, Oregon. Consumers Gas serves the community of Bend with mixed gas, and anticipates receiving natural gas as it is directly on the route of the proposed Pacific Gas Transmission Company. Cascade operates natural gas distribution systems in 21 communities in Washington and Oregon, including Pendleton, Baker, Yakima, Kennewick, and Walla Walla.

With the addition of the two new properties, Cascade will be serving approximately 15,000 customers in 28 communities in Washington and Oregon. Under terms of the merger agreements, Ernest W. Jorgensen, president of Eastern Oregon will become a director of Cascade and vice president in charge of Cascade's Oregon operations and Nick Hollamon, president of Consumers, will become district manager of Cascade with responsibility for operations at Bend.

In Pittsburgh, Pennsylvania, gas lights are burning brightly. Twenty-three gas lights have been installed at Point Park as part of Pittsburgh's Bi-Centennial Celebration. The lights, manufactured by Veritas of London for Equitable Gas Company, are exact reproductions of outdoor gas lights used to light the streets of early Philadelphia. Service contract for Point Park's new gas lights has been awarded to Gas Consumers Service, a company founded 81 years ago for the principal purpose of servicing gas street lights. Although the company changed its emphasis to gas ranges and other appliances as the gas lights were supplanted by incandescent lamps, it now has a job in its original field, keeping gas lights in perfect condition.

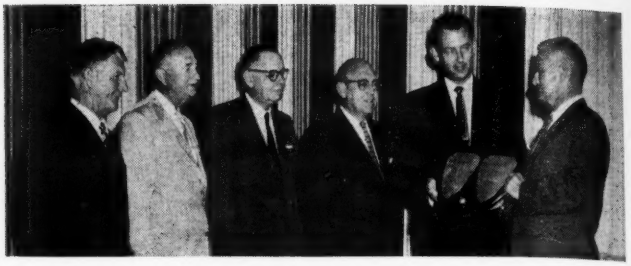
RESIDENTS IN NORTHERN VIRGINIA will get natural gas service eventually, but from whom? Both Washington Gas Light Company and Virginia Gas Distribution Corporation are battling a Virginia State Corporation Commission decision last year dividing the northern Virginia territory between the two gas utility firms. WGL says Virginia Gas wants to extend service only where it can make the most profit — and to prevent any rival from providing better service to large areas of Prince William and Loudoun Counties. Virginia Gas, on the other hand, says their company is under no obligation to provide service where it is economically unfeasible. Decision on who'll sell what to whom and when and where is up to the courts.

Structural steel is up for the new plant of Robertshaw Thermostat Division, Robertshaw-Fulton Controls Company, near the Pennsylvania Turnpike. Construction is proceeding on schedule and the new plant which replaces the R-F plants at nearby Youngwood and Scottdale, is scheduled for completion in mid-1960.



Stopped-action photographs of water turbulence (right foreground) were used in the development of the exclusive self-cleaning features of the recently-introduced Norge combination washer-gas-dryer. Marion Barbee, Norge gas development engineer, is shown evaluating the photographs. In the background Don Barnett, technician, (left) continues to photograph stages of the cycle while Frank Antrim, technician (rear) records observations, and checks elapsed time cycles. The new washer-dryer utilizes a lint screen — made of Monel that measures 15 inches in diameter and is the largest yet furnished by the industry — that collects lint during the drying cycle; the lint is washed down the drain during the next washing cycle, and the screen never needs cleaning.

Traveling display of industrial control devices, believed to be most complete in industry, is now touring nation for Fulton Sylphon Division, Robertshaw-Fulton Controls Company. Display panels feature assemblies and parts representing virtually all items produced by division including some newly-developed items and automatic temperature and pressure controls.



Awards for outstanding achievement for their work in the Pacific Coast Gas Association during the past year were presented to (left to right): Floyd R. Cramer, Southern Counties Gas Co.; Gordon W. Beachy, Pacific Gas & Electric Co.; M. C. Foster, Pacific Northwest Pipeline Corp.; Howard J. Johnson, Southern California Gas Co.; and J. A. Millen, Southern Counties Gas Co.; Edward L. Sibley (far right) Pacific Gas & Electric Co., and chairman of the PCGA awards committee, presented the awards at the association's 66th annual convention.

QUEBEC NATURAL GAS CORPORATION OF MONTREAL foresees a $44,000,000 construction program for expansion and improvement of its natural gas facilities between now and 1963 if public demand continues its present rapid growth. Leonard Milano, executive vice president of the corporation, told New York Society of Security Analysts in New York City that new gas business installed since June 1, 1959, or contracted and awaiting completion of customers' facilities, now totals an estimated annual consumption exceeding 7-billion cu ft and an estimated annual revenue of approximately $4,000,000. In viewing expansion plans he noted that Quebec's engineering and sales departments are now surveying new areas for distribution line extensions.

CONSUMPTION OF GAS BY ELECTRIC UTILITIES in the U. S. during August amounted to 191,437,634,000 cu ft, the largest monthly use of record and an increase of 5.1 percent over the previous high of 182,194,222,000 cu ft burned in July, the FPC has reported in its monthly publication, *"Consumption of Fuel for Production of Electric Energy."* The August total was 20.1 percent above the 159,434,651,000 cu ft consumed in August 1958.

ARIZONA PUBLIC SERVICE COMPANY has received permission to investigate a new gas customer connection policy requiring payment of a $5 service charge along with other gas line extension policies. The $5 charge will be made for all new connections and reconnections. Customers who receive both gas and electric service pay only one $5 charge and there is no charge made for disconnects. "The service charge will provide more equitable distribution of utility costs to the rate payers," notes W. P. Reilly, vice president in charge of customer services for the utility. Company records show 70 percent of the utility's customers rarely move from one location to another, the other 30 percent may move several times a year. "We do not think it fair to ask all rate payers to bear the burden of cost brought about by a small percentage of our customers," Reilly said. Gas line extension policy changes included: free installation of 250 ft of main and 90 ft of service line for customers with refrigerated gas air conditioning; free extension of main up to 150 feet and 75 ft of service line for customers with 3 or more connected uses of natural gas, other than gas air conditioning; and free main extension of 75 ft and 30 ft of service line for customers with two uses of gas.

TEXAS' NEW GAS SEVERANCE TAX is facing its first test in state courts. Michigan Wisconsin Pipeline Company, which sells no gas in Texas, and whose pipeline extends only 1.74 miles into the state of Texas, paid $16,864.56 in taxes under protest and simultaneously filed suit against the state to reclaim the money. The tax involves a 1.5 percent (of sale value) on all gas produced from dedicated wells. It was designed to hit pipeline companies taking gas out of Texas, and is expected to produce $15,600,000 in new revenues for the state in 1960-61.

A NEW CANADIAN GAS CONSULTANT FIRM has been organized in Calgary, Alberta, Canada by Harry E. Palmer, registered professional engineer. The new firm, Palmer Gas Consultants, Ltd., will be available to provide advice on natural gas projects of all kinds including gas management, feasibility economics, design, and construction.

BRISK DEMANDS FOR DISTRIBUTION COMPANY COMMON SHARES during August sent prices to a new all-time high of $41.60 at the end of the month, resulting in a year-to-year gain of 22.3 percent, the American Gas Association reports in its monthly summary of data compiled weekly by Moody's Public Utilities. Average dividend of distribution common shares was up 5.8 percent from a year ago ($1.64 a share), to make the current yield 3.94 percent.

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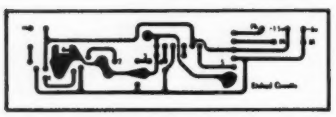
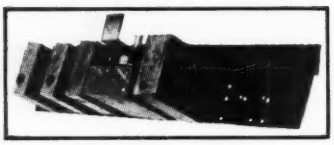
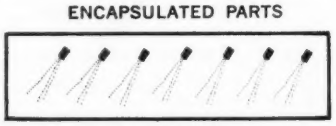
SPECIFICATIONS: Size of cases when clamped together: 9½" x 12½" x 5½" • Size of transmitter and receiver boxes, each: 9½" x 12½" x 2¾" • **Operating weight,** transmitter: 4½ lbs. • **Operating weight,** receiver: 4⅜ lbs. • **Circuit:** Transmitter—one transistor, Receiver—six transistors • **Batteries:** Transmitter—4 size C flashlight cells, Receiver—4 size C flashlight cells • **Switching:** a. Automatic power switching for all "on-handle" operations. b. Automatic "turn-off" when set is not being used.



ETCHED CIRCUITRY



ENCAPSULATED PARTS



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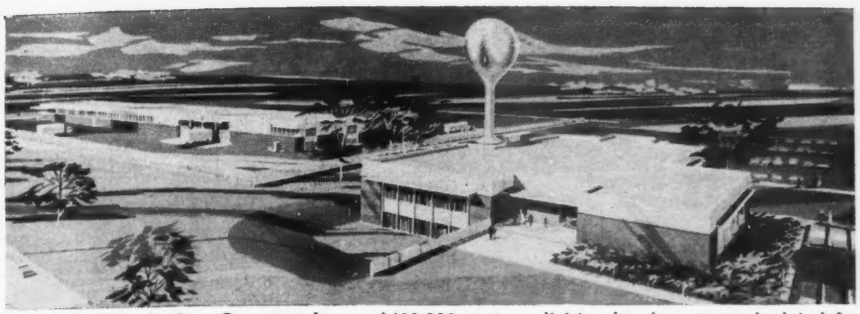

Northern Illinois Gas Company's new $400,000 eastern division headquarters scheduled for completion in December 1960 at Glenwood will include a T-shaped bi-level office building (right) and a rectangular service building (upper left). The new facilities will help NI-Gas meet the needs of the extremely fast-growing south suburban area. A total of 45,000 sq ft will be provided by the two buildings which will be located on a 41-acre site on the east side of Glenwood-Chicago Heights Road at Holbrook Road, about two miles northeast of Chicago Heights. The office building, containing 23,000 sq ft, will house division executive offices, customer service, sales, construction, maintenance, and industrial relations departments. The service building, with 22,000 sq ft, is designed to contain transportation maintenance facilities, storeroom and shops, and men's locker and shower rooms.

NEW ORGANIZATION of gas utility companies and gas equipment manufacturers in eastern Pennsylvania, Delaware, and New Jersey has been formed to promote the use of gas for industrial, commercial, and institutional applications. The group, *The Gas Equipment Guild of Delaware Valley*, was formally organized September 22. Earl G. Mills of York County Gas Co. was elected president; Fred Wagner of the J. V. Calhoun Co., vice president; Frank C. Shermer of Philadelphia Electric Co., secretary, and Robert Mack, of Mears-Kane-Ofeldt, Inc. was elected treasurer.

CONTINUING HIGH DEMANDS FOR GAS by industrial consumers helped push the July total gas sales to ultimate consumers to 15.1 percent above levels a year ago, the A.G.A. reports. Sales for the month totaled 5,558,000,000 therms, up from 4,827,000,000 therms in July 1958. In spite of the nationwide steel strike that began early in July, gas sales to industrial customers showed an annual gain of 15.5 percent.

COOL SEPTEMBER WEATHER SENT SALES SOARING for residential gas central heating equipment reports GAMA. Manufacturers shipped 122,600 gas-fired furnaces, 17,600 boilers, and 27,800 gas conversion burners during the month. The total 168,000, was 10.5 percent more than in the preceding month, 1.8 percent ahead of September of last year. Shipments of **vented recessed wall heaters** (43,900 units), were up 6.6 percent over the same month a year ago. Room heaters and other types of **direct heating equipment** (210,600 units) were down 3.4 percent. **Floor furnace** shipments (14,000) were down 14.1 percent; **unit heaters and duct furnaces** used mainly in commercial and industrial installations (16,500) were up 13.8 percent. GAMA's monthly telegraphic survey of manufacturers also indicated significant increases in other gas appliance shipments. A total of 205,700 **gas ranges** sent to the market during September was the largest number dispatched any month so far this year, and 13 percent more ranges than were shipped in September of last year. Dollar value of the gas ranges during the first 9 months has increased 18 percent over the comparable 9-month period of 1958, a rate nearly 50 percent greater than the increase in unit sales. This difference between the rise in volume and value is not due to inflation, but instead, is termed a direct result of the industry's emphasis on, and the public's response to, the Gold Star Award promotion GAMA says. **Built-in ranges** alone have shown a 60.9 percent jump in sales during the first 9 months; September shipments alone were up 37.7 percent. **Free standing ranges** dispatched during the first 9 months numbered 1,247,200, a 6.2 percent improvement over last year. September totals were 172,100, a 9.1 percent increase. Despite the seasonal slow-down of new home construction, manufacturers shipped 240,000 **gas-fired water heaters** during September, a 4.3 percent increase. **Gas dryers,** (59,409 units) were up 22 percent from September of last year.

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GAS MAIN STOPPER

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AN ENTIRELY NEW LOW COST ALL-PURPOSE DETECTOR

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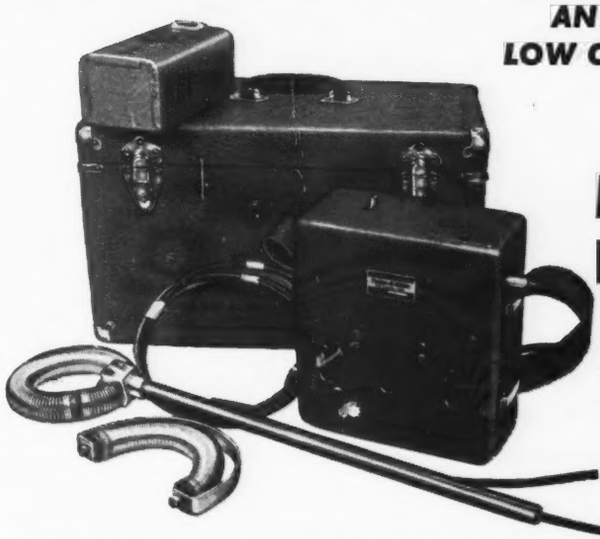
MODEL E-4 DETECTOR



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- D. C. Output
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The Model E-4 Detector is a portable instrument designed for all-purpose work and is adaptable to both large and small pipe. It features direct current, high potential output, accurate bell signal alarm, and is adaptable to both the full circle and half circle electrodes. It is adjustable from 5000 to 20,000 volts D. C. and offers a shock proof, non-destructible type case.

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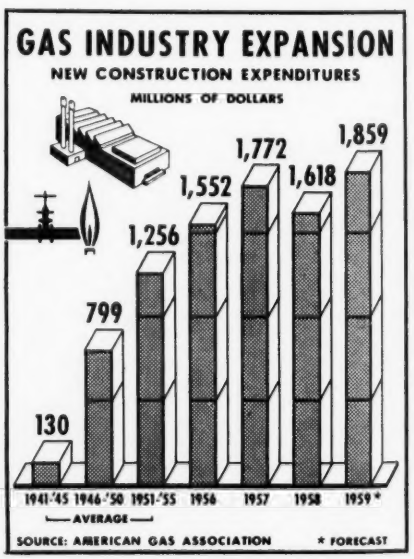
Newsreel

PRESIDENT VETOES COAL STUDY MEASURE — Legislation that would have set up a Federal Research and Development Commission to promote new and wider uses of coal was vetoed by President Eisenhower September 17. In a memorandum rejecting the proposed coal commission, the President noted that the Interior Department already does much of the work that would be assigned to the commission. He said creation of the commission would dilute the Department's "established interest in such matters." He did however, endorse one section of the bill authorizing the Interior Department to contract with private agencies for coal research and recommended that Congress enact it as separate legislation in 1960.

FPC POLICIES ARE OUT OF STEP WITH COSTS, PRICES, AND EARNINGS, Glenn W. Clark, president of the Independent Natural Gas Association of America, said in a speech before his group's annual convention. "It is the task both of individual gas companies and INGAA to convince the FPC and its staff that this is true and that some changes of emphasis are necessary if we are going to be able to satisfy the public demand for natural gas service in a growing economy." Clark charged the FPC with failure to adapt changes in return rates and rate base policies with respect "to the relentless onslaught of inflation." Lack of progress in this area during the past year was, he noted, largely the result of the backlog of pipeline rate cases caused by the "Memphis case" and the absolute necessity for many pipeline companies to get their cases settled in order to make plans for future expansion and activities. "A great deal more attention must be paid during the next year to competition in the coal and allied industries and their attempts to impose restrictions on the use of natural gas. These interests almost succeeded this year in having created an independent coal research commission and a joint commission on a national fuels policy," he noted.



American Gas Association estimates that a record $1.8 billion has been spent for expansion of distribution, storage, and transmission facilities during 1959. Outlays of $1.6 billion in 1958 were twice as large as average annual construction expenditures in the years 1946-50 and 12 times greater than the 1941-45 average.

LIGHT WEIGHT AMERICAN® ALUMINUMCASE METERS

CUTS COSTS IN SHIPPING, HANDLING, and SETTING

- **Dependable and economical.**
- **Light weight and rugged.**
- **Modern and attractive—assures customer acceptance.**
- **Sustained accuracy at lowest cost.**

AMERICAN AL-175

Rated at 175 cfh, the AL-175 is American's latest model to provide a complete line of domestic aluminumcase meters . . . for most domestic services.

AMERICAN 5B-225

Rated at 225 cfh, operates at the conventional nine revolutions per cubic foot and is comparable with the standard 5B Ironcase meter . . . for medium-sized domestic loads.

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Rated at 250 cfh, operates at only 7 revolutions per cubic foot for sustained accuracy through greater power and slow-speed operation . . . for home heating and small commercial loads.

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MEN AT WORK

IN THE GAS DISTRIBUTION INDUSTRY

● **Charles J. Dunne,** assistant treasurer of Long Island Lighting Company, has been appointed an assistant treasurer of the American Gas Association.

● **Onnie A. Maki** has been appointed director of employee relations of United Fuel Gas Company and affiliated companies, succeeding **J. M. Wilson** who resigned recently to enter the private consultant field in employee relations. Maki was formerly director of training and development of the Walworth Company.

● Three major staff changes for Southwest Research Institute, San Antonio, Texas, have been announced: **Maj. Gen. Harry Reichelderfer,** USA (Ret.) has been named administrative vice president. **Dr. James Sharp** and **Henry Korp** have been named technical vice presidents.

● Recent personnel changes at Ohio Fuel Gas Company of Columbus, include the appointment of **Miss Phyllis Floyd** as home service adviser in Ashland, and **Miss Shirley Anne Eckert** as home service adviser in Medina. **Ralph N. Mahaffey,** chief attorney examiner of the Ohio Public Utilities Commission for the past two years, has been named to the O-F legal staff. **John J. Warriner** has been named business promotion representative in Galion. **George G. Murphy,** former machine shop foreman, has been promoted to general shop superintendent at Mount Vernon succeeding the late Herbert F. Woodward. **Gilbert R. Miller,** purchasing agent for O-F at Columbus, retired November 1 after 47 years with the gas company. He started with the company as a production department clerk in 1912 and holds one of the utility's longest current service records.

G. K. Kline

R. C. Swagler

● Recent personnel changes at The Peoples Natural Gas Company of Pittsburgh, Pennsylvania, include the appointment of **George K. Kline,** former assistant to the general superintendent, to general superintendent. He will direct and coordinate administration of production, storage, transmission, and distribution activities of Peoples Gas. **Robert C. Swagler,** former western division manager with headquarters in Glenshaw, has been promoted to assistant to the general superintendent. **Lurting K. Beatty,** former member of the general sales staff, has been appointed air conditioning sales manager and will direct the utility's commercial, industrial, and domestic air conditioning activities.

● Recent personnel changes in the gas department's general office at Public Service Electric and Gas Company of Newark, New Jersey, include the promotion of **W. Kenneth Huggler** from engineer to assistant industrial relations manager; **William Mergner** from engineer to project engineer, engineering department; **Daniel M. Reall** from staff assistant to supervisor stores, and **Charles W. Parsons** from plant chief clerk, West End Gas Plant to supervisor, clerical procedures. **Martin J. White,** engineer in the gas distribution department, has retired on pension after more than 43 years' service with Public Service.

● **Charles E. Little,** former sales manager in the Derby and Wallingford districts, has been promoted to the newly-created post of general sales manager for The Housatonic Public Service Company of Derby, Connecticut.

● **Christy Payne, Jr.,** vice president of The Peoples Natural Gas Company, has been appointed to head an extensive program of market development for Consolidated Natural Gas Company, parent company of Peoples Natural Gas.

● **James B. Ketcham,** training director of the Charleston Group Companies, has been transferred to Columbia Gas System Service Corporation in New York, and promoted to director of training and recruitment.

● **Deane Baker,** formerly of Deane Baker and Associates in Lubbock, Texas, has joined the executive staff of the Somerville Construction Company of Ada, Michigan.

● **George Ames** has been appointed field manager, pipeline sales, for Gar Wood Industries, Inc. He will headquarter in Findlay, Ohio, and represent the complete Gar Wood Buckeye line of ditchers.

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2. UNACCOUNTED-FOR GAS

3. DANGEROUS HAZARDS

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● **Emil Blaha** has been elected to the position of vice president, Ceramic Division, Selas Corporation of America. He was formerly manager, Ceramic Division.

● **Clyde Daniels** has been appointed regional sales representative for Adams Pipe Repair Products for the Texas, Oklahoma, Louisiana and Arkansas areas. He will headquarter in Fort Worth, Texas.

J. A. Scoggin

J. T. Skinner

● Allis-Chalmers Mfg. Co., Construction Machinery Division, has named **James A. Scoggin** to the newly-created position of general service manager of the division. He was formerly a vice president of the Tractomotive Corporation, and continued with Allis-Chalmers as its Deerfield Works sales and service manager after Tractomotive was absorbed earlier this year. Other personnel changes include appointment of **J. T. Skinner** to sales manager, Deerfield products, Construction Machinery Division; and appointment of **Francis C. Schessler** as assistant sales manager, Deerfield Products. Both men were formerly with Tractomotive.

● **P. H. Gauthier** has been appointed contract sales manager for heating and air conditioning products for Perfection Industries, Division of Hupp Corp. He was previously with Remington Corp.

Noble H. Stephens, 61, assistant secretary and assistant treasurer, Northwest Natural Gas Company, died August 22. He has been with Northwest and its predecessor, Portland Gas and Coke Co. since 1923.

John B. Wallis, 56, secretary and administrator of insurance and claims, Pacific Lighting Gas Supply Company, died August 12. He joined Pacific Lighting in 1942 as chief gas accountant.

F. Tom Parks, 69, former vice president and member of the board of directors of Public Service Company of Colorado, died October 22 following a brief illness. He spent 42 years in the utility business holding assignments in refineries, oil and gas production, gas transmission, and gas distribution. Under his direction, natural gas was introduced into Denver, Pueblo, and other towns in Colorado, and into Cheyenne, Wyoming.

Ben C. Adams, Sr., 79, chairman of the board of The Gas Service Company, died of a heart attack October 14. He had been in the utility business more than 56 years; began the job of organizing the Gas Service properties in 1929. Prior to that, he served the Henry L. Doherty utility interests all over the country. His role was that of a roving vice president, trouble shooting any place, at a moment's notice. During his career, Adams held executive titles in several Doherty companies. In 1940 he became president of The Gas Service Company, which was formed from several subsidiaries of Doherty's Cities Service Company.

● **Dr. R. W. Fritts** has been promoted to manager, thermoelectric project, for Minnesota Mining and Manufacturing Company. Other personnel changes in the thermoelectric program include appointment of **Dr. J. D. Richards** as supervisor for materials research; appointment of **William V. Huck** as supervisor for applications research; appointment of **William Krawczak** as product development supervisor; appointment of **Walter H. O'Neal** as product control supervisor; appointment of **Russell Fredrick** as research metallurgist specializing in thermoelectric materials, and appointment of **A. D. Steele** as product sales manager.

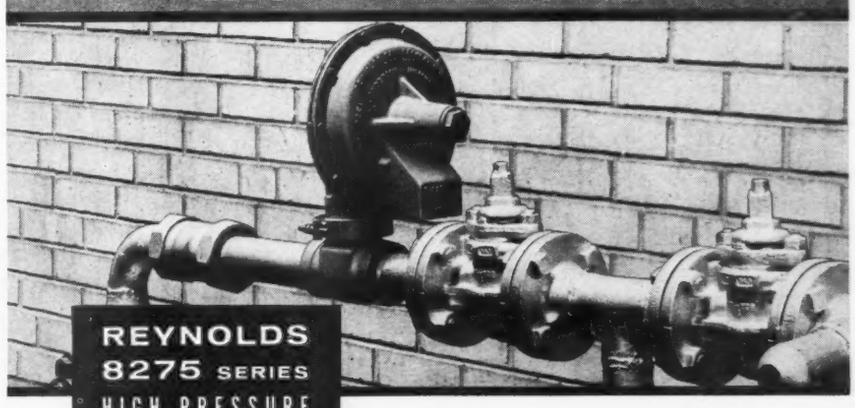
● Blaw-Knox Company, Buflovak Equipment Division, Buffalo, New York, has appointed Mulcare Engineering Company, Inc. of West New York, New Jersey, as sales representatives for Blaw-Knox gas conditioning equipment in the eastern U. S.

● **Everett B. Murphy** has joined the staff of the Liquefied Petroleum Gas Association and the Western Liquid Gas Association. From his office in San Francisco, California, he will act as LPGA's West Coast secretary and WLGA's managing director. In the combined LP-Gas association posts, he will administer WLGA's program of industry representation in behalf of California's LP-Gas marketers and suppliers.

● **Howard W. Scaman,** former advertising manager of Dearborn Chemical Company, has been appointed to the new position of distributor sales manager of the firm. **J. E. Clemens,** who has been assistant ad manager, has been named the new advertising manager.

REYNOLDS

PERFECT HIGH PRESSURE HANDLER!



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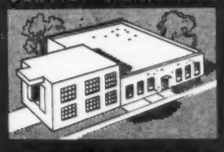

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VERSATILE: Variable head position. Interchangeable with Reynolds 8310 Series.

DURABLE: Corrosion and rust proof. Strong, stainless steel V-band coupling — No threaded connections to rust.

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ANDERSON, INDIANA *A Subsidiary of Arkansas Louisiana Gas Company*

GAS and AIR
Norwalk Check Valves
for high capacity and low pressure drop

Disc-Type
Bulletin No. MN-1000

Disc-Type — for horizontal or vertical operation has new disc design — provides tight shutoff against back pressure. Will open at low pressure.

All parts easily inspected without removal from line. Practically no maintenance or replacement.

Aluminum discs are standard, operate to temperature of 200°F. Stainless steel discs on request, operate to 400°F. Soft seat discs are available.

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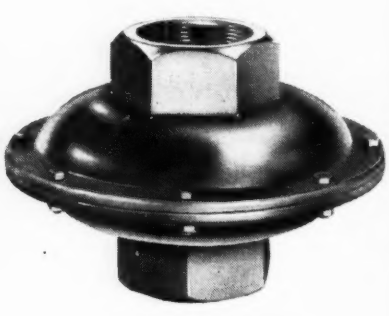
Diaphragm-Type — available in horizontal or vertical designs, these check valves are designed to withstand back pressure of 50 psi (valves for higher back pressures furnished on special order).

Diaphragms of neoprene furnished as standard.

Temperatures to 200°F.

Sizes for horizontal models range from ½" to 4" (6" flanged); vertical model sizes from ½" to 4".

Diaphragm-Type, Horizontal
Bulletin No. MN-2000



Diaphragm-Type, Vertical
Bulletin No. MN-2000

Industrial Combustion Division

Eclipse

ECLIPSE FUEL ENGINEERING CO. 1108 Buchanan Street
ROCKFORD, ILLINOIS

Men at Work

● **John Vilven,** widely known industrial sales executive, has been named general sales manager for Massey-Ferguson Industrial Division, Wichita, Kansas. Formerly he was manager of the western region for Mid-Western Industries, Inc. whose patents and assets were purchased in mid-1957 by Massey-Harris-Ferguson, Inc. to become the Massey-Ferguson Industrial Division.

John Vilven

M. E. Morgan

● **Milton E. Morgan** has been appointed vice president of A. O. Smith Corporation's Permaglas Division in Kankakee, Illinois, succeeding **John H. Brinker** who has resigned to join another company.

● Ebasco Services Incorporated has added five new personnel to its management consulting staff. The three, who will headquarter in New York, are **Carl E. Anderson,** a consultant in the manufacturing and industrial field; **Harold P. Richmond,** former vice president of Public Service Co. of North Carolina who will become a general gas consultant; and **Paul L. Gill,** who will be director of industrial planning. **Clinton J. Sammond,** former manager of industrial relations for Ebasco International Corporation, will be a management consultant at the Dallas office. **Raymond M. Holmes** will supervise management consulting activities in Washington D. C.

● Whirlpool Corp. has announced several recent personnel changes including the appointment of **Paul F. Armbruster,** until recently on roving assignments as distributor development manager for Whirlpool, to southwestern regional manager for the full line of RCA Whirlpool appliances. He succeeds **Bernard P. Collins,** who has transferred to California as a district manager for the gas utility division. Armbruster will headquarter in Dallas, Texas. **H. Thomas Stroop** has been assigned to the position of field sales supervisor, refrigerator division, and **Quentin B. Garman** has been appointed to succeed Stroop as refrigerator promotion manager. Garman was formerly district sales manager in Atlanta for Universal Rundle Co.

● American Meter Co. has announced the relocation of two sales engineers in the southern district of its southwest division — **Eugene D. Rose** has been assigned to the Houston sales office from Garland, Texas, and **Clay G. Braswell** to Garland from Houston.

● **Chas. I. "Chuck" Poole,** formerly division engineer-distribution with Pioneer Natural Gas Co., has opened a complete consulting engineering service to the natural gas industry in the Lubbock, Texas, area.

● **Donald Kuhlenschmidt,** prominent Evansville refrigeration engineer, has been named development engineer for Arkla Air Conditioning Corp., and will be employed in Arkla's research and development department under the direction of vice president **R. K. Eskew.**

Here's a comprehensive report on direct chemical-to-electrical energy conversion, who's doing what, and what it means to the gas industry . . .

Fuel Cell Research and Its Significance to the Gas Industry

R. B. Rosenberg
Institute of Gas Technology
Chicago, Illinois

THE PROBLEM OF EFFICIENT CONVERSION of the chemical energy of fuels into electrical energy has long confronted engineers. The conventional power station usually used for this purpose (Fig. 1) involves:

1. The conversion of chemical energy into heat energy by combustion of the fuel in a furnace,
2. Conversion of the heat energy to mechanical work by means of a heat engine, and
3. Conversion of the mechanical work to electrical energy through an electrical generator.

A heat engine converts heat energy to work by means of a suitable working substance that must pass through a temperature cycle. The working substance absorbs heat at a high absolute temperature, T_1, and rejects it to a cooling system at a lower absolute temperature, T_2. In this cycle, the cooling system absorbs a minimum fraction, $\frac{T_2}{T_1}$, of the heat supplied; a maximum fraction, $\frac{T_1 - T_2}{T_1}$, is available as work.

This limitation (the "Carnot limitation") defines only the theoretical inefficiency of a heat engine. The actual mechanical inefficiencies, heat losses in flue gases, and energy losses from the combustion process of a power plant further decrease the amount of energy available as work. For instance, a power station operating with steam at 500 C (932 F) would have a limiting Carnot cycle efficiency of about 60 percent, but in actual operation would give only about 30 percent efficiency.

A promising means for improving the conversion of chemical energy into work is the fuel cell, which converts chemical energy directly into electrical energy. The fuel cell does not involve a temperature cycle, as does a heat engine, and consequently has no theoretical limitations on its conversion efficiency. It has been shown[1] that the same amount of theoretical work is available from a power plant as from an ambient temperature fuel cell, if the power plant:

1. Recovers the theoretical quantity of work as well as the heat from the combustion step,
2. Discharges reaction products at ambient temperature, and
3. Operates with ambient temperature as the lowest temperature of the working substance.

The inefficiencies of a power plant, due to practical difficulties in fulfilling the above requirements and in operating theoretically (reversibly) greatly exceed the inefficiencies expected due to irreversibilities in operation of a practical fuel cell.

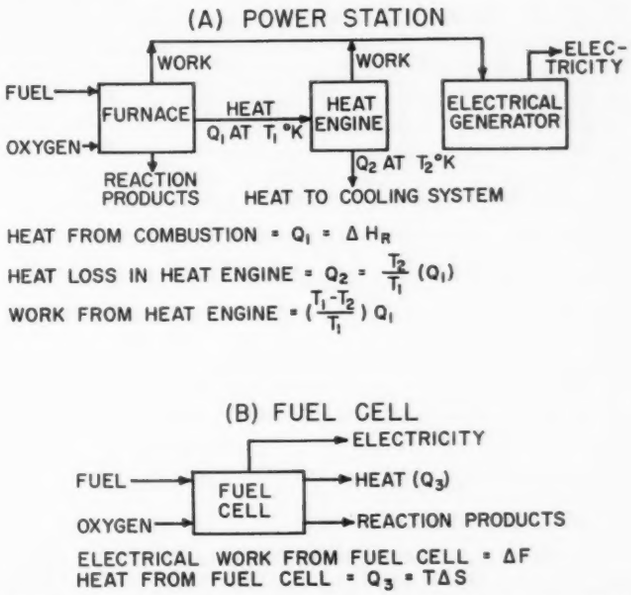


FIG. 1. Comparison of the production of electricity by conventional power stations vs fuel cells.

Fuel Cell Known 150 Years

The fuel cell, an outgrowth of the electrolytic or galvanic cell, first attracted investigators more than 150 years ago. *In principle, the fuel cell is an apparatus that causes a combustion reaction to proceed in two ionic steps.* For example, the combustion of carbon with oxygen would correspond to the reaction $C + O_2 \rightleftarrows CO_2$.

A fuel cell using carbon as fuel would cause this reaction to proceed by the steps:

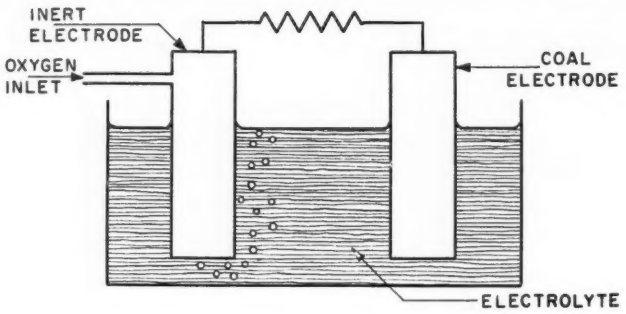
$$C + 4OH^- \rightleftarrows CO_2 + 2H_2O + 4e^- \quad . \; . \quad (1)$$

$$O_2 + 2H_2O + 4e^- \rightleftarrows 4OH^- \quad . \; . \; . \quad (2)$$

The net cell reaction would be the same as the combustion reaction, but the energy release in the fuel cell would be in the form of electricity, rather than heat.

Reaction (1) would take place at the carbon electrode, the fuel electrode in this case. The electrons would pass from the fuel electrode, through an external circuit where they can do work, to the oxygen electrode where Reaction (2) would occur. The electrical circuit would be completed by the transfer of hydroxyl ions through the solution from the oxygen electrode to the fuel electrode.

Three Basic Types of Fuel Cells . . .



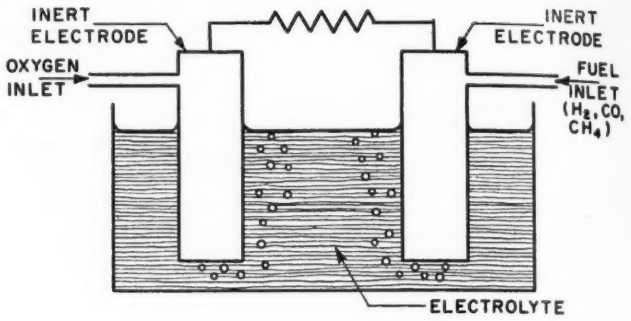
SAMPLE REACTIONS:

OXYGEN ELECTRODE (POSITIVE POLE)	COAL ELECTRODE (NEGATIVE POLE)
$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$	$C + 4OH^- \rightleftharpoons CO_2 + 2H_2O + 4e^-$

OVERALL CELL REACTION

$$C + O_2 \rightleftharpoons CO_2$$

FIG. 2. Direct fuel cell.



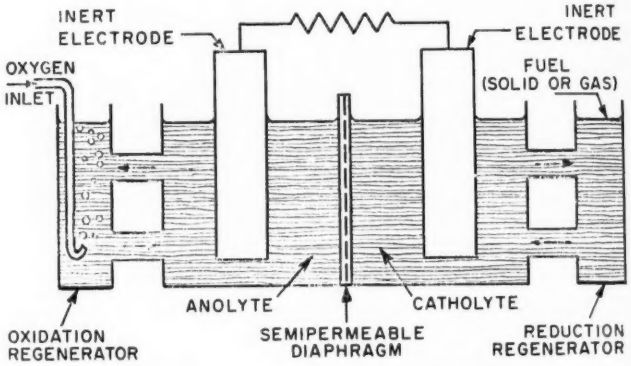
SAMPLE REACTIONS:

OXYGEN ELECTRODE (POSITIVE POLE)	FUEL ELECTRODE (NEGATIVE POLE)
$1/2\ O_2 + H_2O + 2e^- \rightleftharpoons 2\ OH^-$	$H_2 + 2\ OH^- \rightleftharpoons 2\ H_2O + 2e^-$

OVERALL CELL REACTION

$$H_2 + 1/2\ O_2 \rightleftharpoons H_2O$$

FIG. 3. Indirect fuel cell.



ANOLYTE	CATHOLYTE
$2Br_2 + 4e^- \rightleftharpoons 4Br^-$	$2Sn^{2+} \rightleftharpoons 2Sn^{4+} + 4e^-$

CELL REACTION = $2Br_2 + 2Sn^{2+} \rightleftharpoons 4Br^- + 2Sn^{4+}$

OXIDATION REGENERATION	REDUCTION REGENERATION
$4Br^- + 4H^+ + O_2 \rightleftharpoons 2Br_2 + 2H_2O$	$2Sn^{4+} + 2H_2O + C \rightleftharpoons 2Sn^{2+} + 4H^+ + CO_2$

OVERALL REACTION = $C + O_2 \rightleftharpoons CO_2$

FIG. 4. Redox fuel cell.

Research has been centered around three basic types of fuel cells. The first is the **direct cell** (Fig. 2), which uses carbon, coal, or a similar solid fuel as an electrode. The electrode is consumed in the reaction and must be periodically replaced. The second type is the **indirect cell** (Fig. 3). This cell uses a gaseous fuel, such as H_2, CO or CH_4, which is caused to diffuse through an inert electrode. This scheme allows the cell to operate as long as fuel is supplied from an external source, and does not require replacement of internal components of the cell. The third type is known as the **redox cell** (Fig. 4). It uses either a solid, liquid, or gaseous fuel, but does not consume the fuel directly in the electrochemical reaction. Instead, it depends upon an electrolyte pair which reacts electrochemically to produce the cell potential. The oxidized member of the electrochemical pair is then reduced by the fuel, while the reduced member is oxidized by oxygen. The fuel and the oxygen reactions are carried out in separate regenerators external to the cell.

Efficiency Definitions

Voltage efficiency, energy efficiency, and *combustion efficiency* are quantities that may be used to describe the performance of fuel cells.

Voltage efficiency is a measure of the polarization of the cell, that is, the extent to which irreversible processes decrease the cell potential, and is defined by the ratio of actual to theoretical cell voltage.

Energy efficiency is the ratio of the actual energy output of the cell (watt-hours) to the theoretical amount of chemical free energy available from the cell reaction.

Combustion efficiency is the ratio of the theoretical amount of electrical energy that could be produced by a fuel cell operating at a given temperature and pressure, to the amount of heat energy which would be liberated by burning the fuel at standard conditions (25 C and one atm abs). The combustion efficiency is, therefore, the ratio of the free energy of reaction at given conditions, to the enthalpy change at standard conditions.

The voltage and energy efficiencies are determined by actual operation of the cell, and cannot usually be predicted. However, the combustion efficiency for a hydrogen-oxygen fuel cell, as a function of temperature and pressure, is shown in Fig. 5.

Early Work on Fuel Cells

The original experiments on the development of a fuel cell were conducted by Davy in 1801. More than 150 cells have been proposed since that time, and have been comprehensively reviewed by several authors.[2,3,4]

The simplicity and directness of the carbon-oxygen fuel cell appealed to many of the early investigators; consequently, the early history of fuel cells consisted of a series of attempts to develop a workable direct cell.[5,6,7] The mechanism of the operation of a fuel cell requires that one or both of the reactants form ions. Carbon does not, however, form stable ions at any practical temperature, and oxygen ionizes slowly except under very special circumstances. These restrictions dictate operation at high temperatures to attain an appreciable rate of reaction.

The use of high temperatures led to the study of molten electrolytes,[8] and subsequently to solid electrolytes.[9,10] The work done by Baur and his associates at Zurich is of particular importance in connection with modern developments. A solid electrolyte composed of a mixture of tungstic oxide and rare earth oxides was used at 1100 C (Fig. 6).

All of the direct cells had major drawbacks that made them impractical. The high operating temperatures involved heat losses that greatly affected efficiencies. Many of the cells were not true carbon cells, but operated by means of a reaction between the carbon and the electrolyte. The

electrochemical reaction apparently took place between these secondary products and the oxidant, leading to greatly reduced cell life, and increased polarization.

Although Baur avoided the latter difficulty, as well as the problem of concentration polarization by the use of a solid electrolyte, he had the additional problems of:

1. Instability of the electrolyte,
2. Corrosion of the container at elevated temperatures,
3. High electrical resistance in the electrolyte,
4. Conversion of the tungstic oxide to lower oxides of tungsten under load,
5. Accumulation of ash with eventual short circuit of the cell, and
6. Inability to completely utilize the carbon.

Apparently, to evade these direct cell problems, Baur and Preis[11] turned to the use of producer or water gas in 1938.

The greatest number of fuel cells that have been proposed may be designated as **indirect cells**; that is, they operate on fuels stored external to the cell. The first record of such a cell is from the work of Grove[12] in 1839, in which he reacted gaseous hydrogen and oxygen to produce liquid water and energy.

The most important of the early indirect cells was the **hydrogen-oxygen cell** developed by Mond and Langer[13] in 1889. Perforated platinum foil electrodes, coated with platinum black, were immersed in a dilute sulfuric acid electrolyte. The cell could generate only a low current density and required hydrogen of very high purity to prevent poisoning of the platinum catalyst.[14] Many modifications of this cell have been constructed in an attempt to attain improved performance and lower initial cost. None of these attempts met with significant success. The Mond and Langer cell, however, provided the basis for some of the more recent fuel cell developments.

An important step in the development of the indirect fuel cell was the introduction of *diffusion electrodes* by Schmid,[15] who studied the impregnation of porous carbon with platinum. The cell was operated by introducing hydrogen inside the porous structure and allowing the gas to pass through the electrode. This arrangement resulted in a minimum polarization under small current drain.

In the early development of the indirect cell, a variety of gaseous fuels were tried, such as carbon monoxide,[16] acetylene and other hydrocarbons,[17] and sulfides,[18] as well as hydrogen. The only success was attained with hydrogen, and even this was very limited. The difficulties in making a gaseous fuel electrochemically active at normal temperatures led subsequent investigators to consider high temperatures to increase electrode reaction rates for the gaseous fuels, just as they had previously for carbon.

The earliest high-temperature indirect cells (1902) used antimony, tin or lead anodes, and molten salts or oxides as electrolytes.[19] The reaction rates of the gas and electrolyte at the electrode-electrolyte interface were low, and remained unsatisfactory even at elevated temperatures. The internal surface areas of the electrodes were increased, but the problem of wetting them was not solved.

Aqueous electrolytes have a general tendency to displace adsorbed gases from the active electrode surface, which greatly reduces the current capacity of the cell. The following methods have been suggested to eliminate this problem:

1. Discontinuous electrode service; that is, removal and drying of the electrode after polarization,[2]
2. Use of a differential gas pressure to prevent the liquid from entering the pores,[19]
3. Use of a paraffin or similar coating on the electrodes, to allow passage of gas but not liquid,[2] and
4. Use of nonaqueous electrolytes.

The best early solution was that of Baur,[11] which called for the use of solid electrolytes. The Baur cells were almost

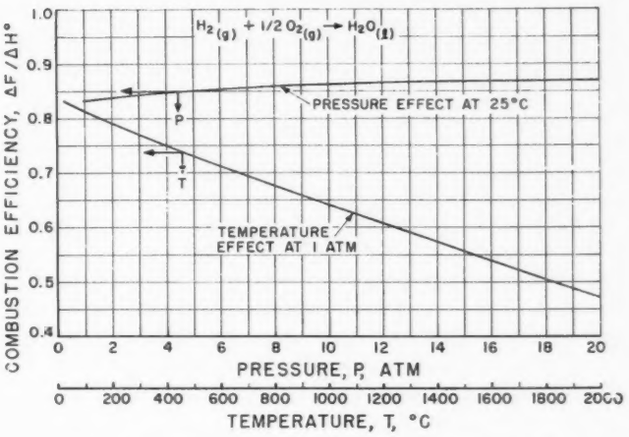


FIG. 5. Combustion efficiency for a $H_2 - O_2$ fuel cell.

free from polarization and rapidly attained steady operation under load. The difficulties met with electrolytes in the direct cell, however, also appeared in the indirect cell.

Some interest developed in the early 1900's in the use of carbon or a gaseous fuel in a redox fuel cell. It was proposed to use electrochemically active materials to generate electrical energy in an electrochemical cell, and to regenerate these materials externally with fuel and air respectively. These early redox cells[20,21,22,23] eliminated difficulties due to slow reaction of the fuel, but they could not be operated at current densities of commercial interest.

Recent Work on Fuel Cells

Research in recent years has centered primarily on indirect cells. In 1947, Davtyan[24] reported work on several types of fuel cells under study at a number of research institutions in the U.S.S.R. (Fig. 6). He described a hydrogen-oxygen cell similar to that developed by Mond and Langer, but claimed simpler, cheaper construction and higher current densities.[25] A detailed study of the potential of various electrode materials was conducted. Nickel was found to be the best catalyst for the oxygen electrode, and silver for the hydrogen electrode. The cell employed an electrolyte of 35 percent potassium hydroxide, and had an open circuit potential of 1.124, compared with the theoreti-

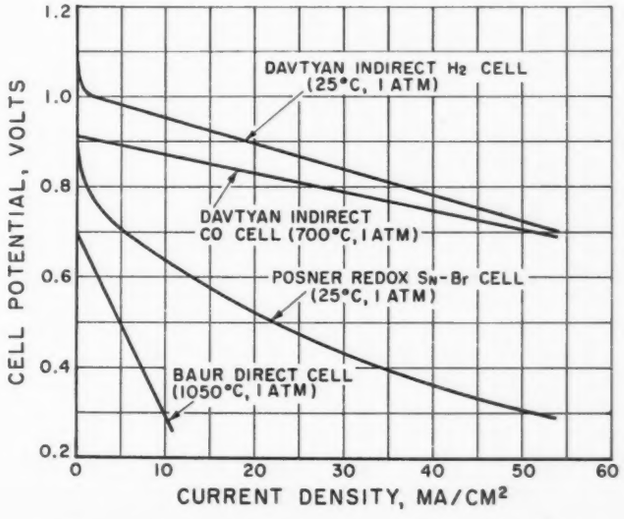

CELL POTENTIAL, VOLTS
DAVTYAN INDIRECT H_2 CELL (25°C, 1 ATM)
DAVTYAN INDIRECT CO CELL (700°C, 1 ATM)
POSNER REDOX Sn-Br CELL (25°C, 1 ATM)
BAUR DIRECT CELL (1050°C, 1 ATM)
CURRENT DENSITY, MA/CM²

FIG. 6. Operating characteristics of various fuel cells.

cal value of 1.232. After the addition of alumina or other promoters to the hydrogen electrode, a current density of 35 ma per sq cm (32.5 amp per sq ft) was achieved at 0.75-v. The effects of extended operation, or of impurities on the cell performance, were not described.

In 1954, Adams[25] constructed a cell based on Davtyan's design, but was unable to reproduce his results. Rather than waterproofing the electrodes as Davtyan did, Adams used a diaphragm between the electrodes and the electrolyte. The maximum open circuit potential of the cell was 0.73-v, which is considerably below the theoretical potential. The current density was less than 2 ma per sq cm, probably due to the high resistance of the diaphragm. Adams found that, when the electrodes were reversed from the arrangement recommended by Davtyan, the voltage characteristics of the cell were at least as good as before.

A possible explanation of the low open-circuit potential has been suggested, based on the work of Berl,[26] who found that the oxygen reaction at graphite and activated carbon electrodes corresponded to:

$$O_2 + H_2O + 2e^- \rightleftarrows HO_2^- + OH^- \quad . \; . \quad (3)$$

rather than

$$\tfrac{1}{2}\, O_2 + H_2O + 2\, e^- \rightleftarrows 2OH^- . \quad . \; . \quad (4)$$

For a reversible fuel cell operating with a hydrogen electrode, a theoretical standard voltage of 0.75 would be obtained if Reaction (3) occurred at the oxygen electrode; a theoretical voltage of 1.23 would be obtained if Reaction (4) were followed.

The potential of a hydrogen-oxygen cell with the oxygen electrode reaction controlled by Reaction (4) is independent of hydroxyl ion concentration; if Reaction (3) controls, the cell potential is a function of both hydroxyl and peroxide ion concentrations. The low experimental voltage was taken as an indication that Reaction (3) controls, rather than (4), as had been presumed, and that the peroxide chemically decomposes before it can electrochemically react at the hydrogen electrode.

The tentative conclusion that the observed voltage is controlled by Reaction (3) was confirmed by Kordesch and Marko,[27] who reported in 1951 that electrodes of activated porous carbon, impregnated with metals and metallic oxides, could maintain current densities of 30 ma per sq cm without excessive polarization. At these electrodes, the reaction corresponded to Reaction (4) under optimum conditions, but after substantial current drain, or after a considerable time on open circuit, appeared to be that of Reaction (3).

McKee and Adams[28] constructed a cell which operated at 1200 C and utilized an electrolyte of the Baur type (tungstic and ceric oxide mixture). They obtained low yields of only 19 ma per sq cm at 0.45-v, and 10 ma per sq cm at 0.6-v. The open circuit potential was 0.68-v. The cell showed a gradual increase of internal resistance under load, which was caused by the irreversible reduction of the tungstic oxide in the electrolyte.

Davtyan[24] claimed to have overcome the problem of McKee and Adams by adding sodium carbonate and soda-lime glass to the Baur solid electrolyte. The cell was operated at 700 C, and produced a current of 20 ma per sq cm at 0.785-v, and 32 ma per sq cm at 0.75-v. The fuel was a 50-50 mixture of hydrogen and carbon monoxide (theoretical open circuit potential of 0.98-v). Davtyan reported that the electrolyte fractured due to thermal shock. Also, operation for extended periods was not achieved, apparently.

Gorin[29,30,31] of the Pittsburgh Consolidation Coal Company patented a method of using the heat generated in a fuel cell of the Davtyan type to sustain the endothermic reaction of steam, air, and carbon to form carbon monoxide and hydrogen for use as fuel gases in the cell. Recently, Gorin[32] has reported that his work, paralleling that of Ketelaar[33,34] at the University of Amsterdam, has resulted in a cell that has a life of at least six months. The cell has an electrolyte composed of a matrix of porous magnesia refractory impregnated with a molten carbonate mixture. The cell yields 126 ma per sq cm at 0.4-v at 750 C with hydrogen as fuel; it yields 60 ma per sq cm at 0.2-v at 750 C and 60 ma per sq cm at 0.4-v at 825 C with carbon monoxide-carbon dioxide mixtures (Fig. 7).

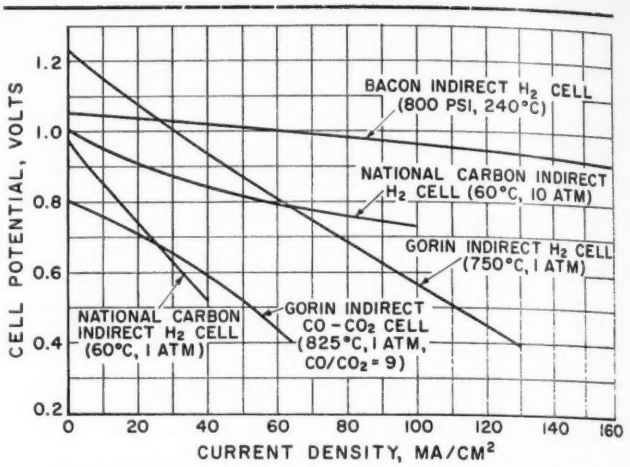


FIG. 7. Operating characteristics of various recent fuel cells.

The only significant work on direct cells reported in recent years is that of Bischoff, Justi, and Spengler.[35,36,37] A cell proposed by Bischoff and Justi operated at 700 C with a fused sodium carbonate electrolyte, and powdered carbon as fuel. Cell temperature was limited to a maximum of about 700 C, since carbon monoxide rather than carbon dioxide would be the main product of the reaction above 700 C, which would cut the current yield in half. The cell had a very high internal resistance, and produced a very small current.

Another cell proposed by Bischoff, *et al*, used a solid sodium carbonate electrolyte. This cell was capable of producing 99 percent of theoretical voltage, and maintained this voltage for several months when operated under negligible current output. Under actual load, the cell became inoperative in a few days.[38]

Posner[39] and co-workers (1955) reported a study of the redox-type fuel cell with coke or coal as fuel, and air as oxidant. Their cell consisted of a stannic-stannous catholyte, and a bromine-bromide anolyte, separated by a semipermeable membrane. Anolyte regeneration with air proceeded very well when catalyzed by oxides of nitrogen. Catholyte regeneration with coal proceeded very slowly even at 160 to 180 C, and oxidized only 30 percent of the coal. The cell polarized severely under load and produced only 50 ma per sq cm at 0.29-v (Fig. 6).

One of the most highly developed of the present day fuel cells is the hydrogen-oxygen cell developed by Bacon.[40,41,42,43] The Bacon cell operates at about 240 C and 50 atm, and has produced a current of 1076 ma per sq cm at 0.6-v (Fig. 7). The electrodes are formed of sintered nickel with 30 micron pores; the electrolyte is 27 percent potassium hydroxide. The development of the Bacon cell was originated in England, and is being continued in the United States by the Patterson-Moos Division of the Universal Winding Company.

Current Research and Development on Fuel Cells

Most of the current work on fuel cells is being conducted in industrial laboratories, and very little information is being published. Some basic research related to fuel cells

is being done by academic institutions and research organizations.

The greatest amount of research is being done on the development of an ambient temperature indirect cell. National Carbon[44,45] has constructed a hydrogen-oxygen cell that is capable of producing a current density greater than 100 ma per sq cm at elevated pressures for short periods (Fig. 7). A more recently developed cell reportedly exhibits a slight polarization under small loads but shows no further decrease in voltage up to 500 ma per sq cm. The cell can develop useful power at 20 C, and under load operates autothermally at 50 to 70 C. The performance of the cell with air at 150 psig is comparable to that with oxygen at ambient pressure, if the air electrode is continuously purged of nitrogen, to maintain a uniform concentration of oxygen at the electrode. The electrolyte is strong caustic, which becomes diluted when the cell is producing a large current density.

National Carbon reports that the accumulation of carbonate from carbon dioxide in the feed gases does not impair the operation of the cell. National Carbon is also developing ambient cells to operate with fuels such as formaldehyde and methyl alcohol.[46] It has obtained 3 ma per sq cm at 0.8-v from a 30 percent formaldehyde solution, and slightly smaller outputs from alcohol. Other work with ambient temperature indirect cells is being conducted by Marshall, Ltd. in England, Justi in Germany, Chrysler Corporation, Electric Storage Battery Company, Allis-Chalmers, General Electric, the Missile Systems Division of Lockheed Aircraft, the Army Signal Corps, and Patterson-Moos.

Justi,[47] in Germany, has developed an ambient temperature hydrogen-oxygen cell which has only 0.03-v polarization at an output of 750 ma per sq cm. The cell uses pyrophoric nickel, and nickel-silver mixtures, for catalysts at the hydrogen and oxygen electrodes, respectively. An open circuit potential of almost one volt can be obtained; it is claimed to be only slightly affected by impurities in the feed gases.

Allis-Chalmers[48] has carried out a study of a cell operating at elevated temperatures, and a preliminary survey of the redox cell, in addition to the primary effort on an ambient temperature hydrogen-oxygen cell.* Esso Research and Engineering Company reported some success with a cell using ethane as fuel.[49] It hopes to develop the cell to operate on liquid hydrocarbon fuels such as heating oil. Stanford Research Institute, and King's College, London, are currently conducting research on various types of redox cells.

Lockheed[50] is conducting research on an ambient temperature hydrogen-oxygen cell designed to produce 100 watt-hours per pound of cell; also, a redox cell is under development. Lockheed is considering the utilization of fuel cells as power sources in space technology applications, and has concluded that the redox cell is best for most such cases.[51]

General Electric is working on several types of fuel cells. It has activities underway on a cell operating on gasoline and air, which may be capable of overall conversion efficiencies of 55 to 65 percent. The cell is basically a hydrogen-air fuel cell which employs a catalyst to convert gasoline into hydrogen. This development is under Army sponsorship and is being considered for space-vehicle power plant applications.[52]

General Electric reportedly is also conducting research on a redox cell.[53] The company's original work, based on that of Posner, utilized a bromine-tin redox pair; however, it was unable to duplicate Posner's results. The present cell uses a titanium catholyte and an undisclosed anolyte; complexes of iron, cadmium, and cesium were mentioned as anolytes, but presumably the system used is a complex of another metal. The cell uses reformed hydrocarbons over a palladium black catalyst to regenerate the catholyte, and air to regenerate the anolyte. It is reported that the activity of the palladium catalyst increases with use. The cell has produced about 160 ma per sq cm at about one volt, and has operated continuously for as long as 16 days. It has been asserted that when the overall cell efficiency reaches 40 percent, General Electric plans to put the cell into production.

The third type of cell under development at General Electric embodies a unique electrolyte.[54,55] The use of ion exchange resin membranes as fuel cell electrolytes was proposed on the basis of the following properties:

a. High electrolytic conduction,
b. Negligible electronic conduction,
c. Negligible permeability to uncharged gases, and to ions charged oppositely from the exchanging ion, and
d. High mechanical strength, and convenient forms for favorable cell geometry.

Ion exchange cells have been operated as ambient temperature hydrogen-oxygen cells, and have produced currents up to 40 ma per sq cm at 0.82-v for periods up to 100 days. Although the current density and the cell efficiency are low, the power output is high. A yield of ½ kw per cu ft is predicted. Research on various types of electrode catalysts, anion and cation exchange resins, and heat transfer problems, is currently being conducted.

Mine Safety Appliances reportedly is currently working on a cell operating with lithium, calcium, strontium, or barium hydrides that are thermally decomposed to the metal and hydrogen at about 900 C. The metal and hydrogen then recombine in the fuel cell reaction, producing electricity and the metal hydride. Thus, the cell involves the conversion of the heat of decomposition of the hydride to electrical energy, in a cyclic process. The cell produces an open-circuit potential of 0.72-v and has an output of about 3 watts per pound of cell. The overall efficiency is about 12 percent. It is hoped to raise this efficiency to about 40 percent.

Research on the fundamentals of electrode catalysis and electrode composition is being conducted at Pennsylvania State University.[56,57] This work is primarily concerned with the effect of chemisorption of the fuel and oxidant on the performance of the cell. Work on catalysis of fuel cell electrode reactions is also underway at Western Reserve University (Cleveland, Ohio),[58] and at Alfred University (Alfred, New York). A fundamental study of high-temperature fuel cells was recently completed at the University of Amsterdam.[34] Work on high-temperature molten and solid electrolyte cells is underway at Sondes Place, England.

High-temperature, high-pressure aqueous electrolyte cells are being studied by United Gas Corporation.

The Institute of Gas Technology is currently conducting research on two types of fuel cells. The first, a redox cell with methane for fuel, is being studied as part of the Institute's basic research program, and is jointly supported by the American Gas Association, United Gas Corporation, and IGT. Research on this cell is presently concerned with the catholyte regeneration with methane. Preliminary data have shown that the regeneration of a cuprous copper catholyte by methane will proceed to small extents at 100 C and one atmosphere. Indications are that the rate and extent of the reactions can be improved substantially, and that this catholyte system may be applicable to a redox cell using natural gas as fuel. IGT has also initiated a study on the development of an indirect cell operating on the products of the reforming of methane.

*A report on the latest development by Allis-Chalmers appears in a separate article in this issue.

Advantages and Disadvantages of Major Cell Types and Fuels

Research has indicated that the development of a practical direct fuel cell is unlikely. The development of ambient or high-temperature indirect or redox cells, however, for domestic and commercial applications appears to be promising. There are differences of opinion about which of the proposed types of cells is most likely to become practical. These various opinions are primarily due to differences in emphasis placed on the relative importance of cell efficiency and cell power output.

The pros and cons of the various cells have been summarized:

Ambient-Temperature Indirect Cells:

1. Efficiencies can be higher than in high-temperature cells; heat losses are very low.
2. Although beneficial effects of high-temperature operation on cell voltage and current output are conceded, it is maintained that these would be cancelled out by effects of unavoidable heat losses. To obtain high rates of reaction, catalysts are required which may be easily poisoned by small amounts of impurities in the feed gases. Side reactions may affect cell potential and output.
3. Proponents of the high-temperature indirect cell take the the position that achievement of maximum efficiency for a given fuel is more important than output. Since maximum efficiency is relatively easy to obtain, research emphasis is placed on catalysts to improve reaction rates (cell output), and decrease sensitivity to feed impurities, and on mitigation of polarization effects.

High-Temperature Indirect Cells:

1. Polarization effects can be significantly less at high temperature because of higher diffusion rates. Also, rates of reaction are generally higher at higher temperatures. Catalysts employed in this cell are less likely to be poisoned by feed impurities than those used in the ambient-temperature cell.
2. Although difficulties in maintaining high efficiencies at high temperatures are conceded, it is maintained that improvements in voltage and current output, due to greater diffusion and chemical rates, respectively, are worth a sacrifice of some efficiency. Side reactions may, however, decrease the cell potential and output.
3. Proponents of the high-temperature indirect cell take the position that achievement of the largest possible power output per unit of electrode area, or cell volume, is more important than efficiency. Since output seems to be most readily maximized at high temperatures, considerable effort is placed on engineering techniques to improve efficiency. Also, since high temperatures preclude the use of relatively low resistance aqueous electrolytes, research on electrolytes is emphasized.

Redox Cells:

1. The reaction of catholyte and anolyte in the electrochemical cell of the redox fuel cell can be carried out rapidly and with low activation polarization, even at low temperatures. Thus combined advantages of high cell output and efficiency are possible. Side reactions are highly improbable. Impurities in feed gases are not likely to be important.
2. Slightly lower theoretical voltages are available from a redox system than from an indirect cell using the same fuel and oxidant. Also, concentration polarization effects may be equally important in indirect and redox cells. In addition, the necessity of using a diaphragm raises problems of increased internal resistance, and/or unwanted diffusion of the redox ion pairs across the diaphragm. Development of concentration redox cells (ion pairs identical in anolyte and catholyte), seems to be practically eliminated, because of the low voltages that are obtained.
3. Proponents of the redox cell take the position that the above problems involved in operation of the electrochemical cell part of the redox fuel cell can be attacked profitably with conventional methods of electrochemical engineering; need for major research on catalysts, or nonaqueous electrolytes, is not indicated. Emphasis is placed on development of data on catholyte regeneration with various fuels, problems of heat economy, and arrangements of the units to reduce overall volume.

Similar disagreements exist concerning the optimum fuel for use in the various types of fuel cells. A summary of the arguments pro and con for the important fuels currently under consideration is presented below:

Natural Gas:

1. Fuel costs are low and the fuel is generally available; impurities in some natural gas streams may affect indirect cell performance.
2. Cell outputs are low due to the relative inertness of methane; high temperatures are required to attain high reaction rates.
3. Proponents of this fuel take the position that fuel costs are more important than cell output. Research emphasis is placed on development of catalysts for indirect cells, and on catholyte regeneration in redox cells.

Hydrocarbon-Carbon Monoxide Mixtures and Process Hydrogen:

1. Fuel costs are intermediate between those of natural gas and pure hydrogen. Impurities in feedstock will affect the performance of indirect cells.
2. Cell outputs are much greater than those attainable with methane, but substantially less than with pure hydrogen; high temperatures are required for rapid reaction rates.
3. Proponents of this fuel take the position that the increased output made available by converting natural gas, or other fossil fuels, justifies the cost of conversion and the efficiency losses incurred. Research is directed to development of improved catalysts which are more active for the carbon-monoxide reaction, and less sensitive to impurities.

Pure Hydrogen:

1. Fuel costs are very high, and fuel is not as readily available; impurities in most industrial hydrogen streams affect cell performance.
2. Cell outputs are high even at ambient conditions; moderately high temperatures yield very rapid rates of reaction.
3. Proponents of this fuel take the position that large power output per unit of electrode area, or, more importantly, per unit of cell volume, is of more significance than fuel cost. Research emphasis is on improved catalysts to make the cell less sensitive to hydrogen stream impurities, reduce purification costs, and achieve more extensive applicability for the fuel.

TABLE 1. Possible Fuel Cell Applications in the Gas Industry.

SUGGESTED APPLICATIONS	RESTRICTIONS Type of Fuel Available	SPECIFICATIONS Cell Power Output per Unit Volume	Cell Energy Efficiency	Type of Cell
I Large Power Loads				
Base-load generation of electricity	a) Natural gas	—	At least 40%	High-temperature indirect, or redox
	b) CO-H_2, process hydrogen	—	High	High-temperature indirect, or redox
	c) Pure hydrogen	—	Very high	Low-temperature indirect
II Moderate Power Loads				
Residential and small commercial central power supply	a) Natural gas	Large	—	Redox or high-temperature indirect
	b) CO-H_2, process hydrogen	Large	—	
Recharging stations for battery powered vehicles	a) Natural gas	—	Moderate	High-temperature indirect, or redox
	b) CO-H_2, process hydrogen	—	High	
III Small Power Loads				
Gas-fueled, electric appliances	Natural gas	Large	—	Redox or high-temperature indirect
Refrigerator convenience light	Natural gas	Small	—	Ambient-temperature indirect
Street light	Natural gas	Small	—	Ambient-temperature indirect

Fuel Cell Applications in the Gas Industry

It appears that the three major types of cells known today, and the three important fuels, all have important advantages, and disadvantages. Therefore, the choice of an appropriate cell will certainly be affected by many characteristics of the particular application. To illustrate the diversity of applications that are conceivable for the gas industry, a few are presented in Table 1.

At the present stage of fuel cell development, it does not appear feasible to expect to attain both a high power output per unit volume and a high efficiency. Therefore, in each instance, the more important of these two features have been specified in Table 1.

The development of a practical natural gas cell for these applications would, of course, be most desirable. Development of cells operating on hydrogen-carbon monoxide mixtures or process hydrogen, however, may be almost as desirable. It may be feasible to distribute these fuels from centrally located natural gas conversion installations. Alternatively, natural gas may be supplied to individual natural gas reforming-fuel cell units. In some areas, economics might favor production of relatively pure hydrogen from natural gas for special applications.

In summary, indications are that it may be attractive in the future for the gas industry to become the prime energy supplier for several types of fuel cell applications. Whether or not this will be very attractive, economically, is not clear at this time. Recent developments in the fuel cell field, however, appear to justify the conclusions that this prospect is technically feasible.

Acknowledgment

This study was conducted as a part of the basic research program of the Institute of Gas Technology with the financial assistance of the American Gas Association and United Gas Corporation. The guidance and counsel of E. B. Shultz, Jr., E. H. Lyons, Jr. and H. R. Linden are gratefully acknowledged. This article was prepared from a presentation made at the 1959 A.G.A. Production Conference.

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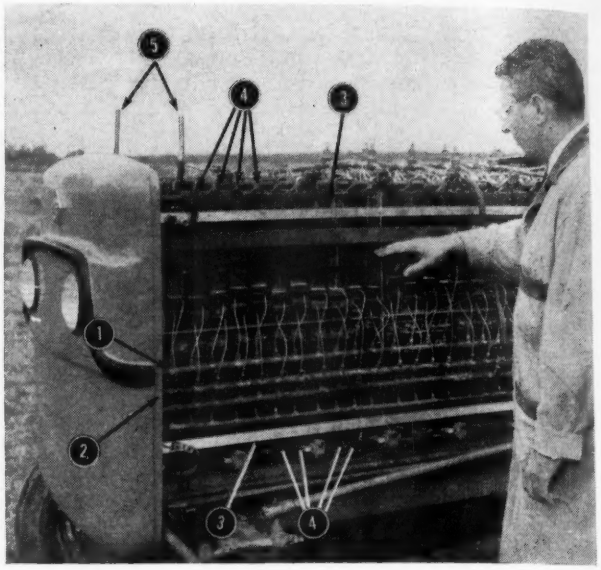
* * *

Mixture of fuel gases — chiefly propane — and oxygen react in an electrolyte inside 1008 fuel cells to provide 15-kw electrical power for a 20-hp d-c motor that drives this experimental tractor. Compact controller to left of driver controls tractor's speed and direction.



Details of fuel-cell system: 1- Propane inlet line (oxygen inlet line is on other side); 2- Gas exhaust line; 3- Bus bar to carry power to controller and motor; 4- Nine-cell power unit; 5- Auxiliary exhaust line to remove fuel gas if supplied too rapidly.

Fuel-Cell Tractor Uses Low Cost Propane

HARNESSING POWER PRODUCED FROM 1008 PROPANE-FED FUEL CELLS, a 20-hp direct-current motor driven tractor with a drawbar pull of 3000-lb has been unveiled by Allis-Chalmers Manufacturing Company at Milwaukee. The research vehicle's power supply of 15-kw is produced in 112 units of nine cells each — arranged in four banks — from which electrical power can be taken in a variety of combinations.

Fuel for the cells is provided by a mixture of gases — principally propane. The gases are fed into the cells through a system of tubing and, once in the cells, the gases react in an electrolyte. A catalyst coating on the electrodes of each cell aids the reaction.

Chemical reactions within the cells cause a direct current to flow through an external circuit, which is connected by bus bar to a standard controller. The compact controller regulates the power supply to a standard 20-hp d-c motor, providing speed control and allowing the driver to reverse the vehicle's direction by reversing polarity of the current flow to the motor.

Fuel supply for the tractor—oxygen and the propane gas mixture — is carried in tanks mounted in brackets on the vehicle.

Fuel cells used in the tractor are a new development — the first to use a low cost fuel such as propane or natural gas. Exact workings of the cells are still secret, to protect patent possibilities, but company spokesmen point out that the success of the cells is due to use of a catalyst, allowing cell operation at atmospheric pressure and ambient temperature.

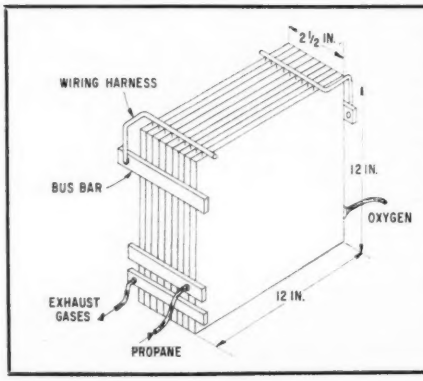
Each cell measures ¼-in. thick by 12-in. square. Nine cells are arranged in each unit, and 112 units — arranged in four banks — provide the 15-kw output needed to power the tractor.

Unlike a conventional tractor, there is little waste space in the vehicle's "power plant." Fuel cells can be mounted in every corner of the vehicle. Researchers are still working to determine an optimum size for the cells, which may produce even more compact designs for future fuel cell power plants.

In the case of stationary power plants, the researchers point out, a plentiful fuel supply can be had without need for storage tanks; the device can be connected simply to the local gas company's supply line.

Even though the experimental fuel cell tractor is of commercial size, it is still a research vehicle, notes Dr. H. K. Ihrig, director of research and a vice president of Allis-Chalmers. The company is not considering producing the tractor commercially; refinements in the cells are needed, and a production-model tractor would have to be designed to match the powerplant — eliminating such items as conventional drive shafts and differentials by using individual electric motors at each drive wheel.

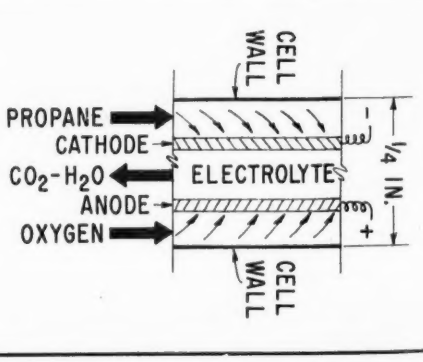
Despite its "research vehicle" tag, the fuel-cell tractor portends other future developments — such as fuel-cell powered autos, trucks, and buses, as well as power plants for homes and factories, and use in military weapons and space vehicles. * * *



Details of fuel cell and of 9-cell unit. In the cell, the fuel gas dissociates into hydrogen and carbon ions at the cathode. Catalyst speeds this reaction. Electrons released travel out through external circuit, return to anode where oxygen molecules capture them. The oxygen molecules, surrounded by excess electrons, become negative ions. In the electrolyte, carbon dioxide and water vapor are formed as exhaust gases as the hydrogen, carbon, and oxygen react. Use of dry electrolyte allows cells to be mounted in any position.

◊ **Details of 9-cell unit.**

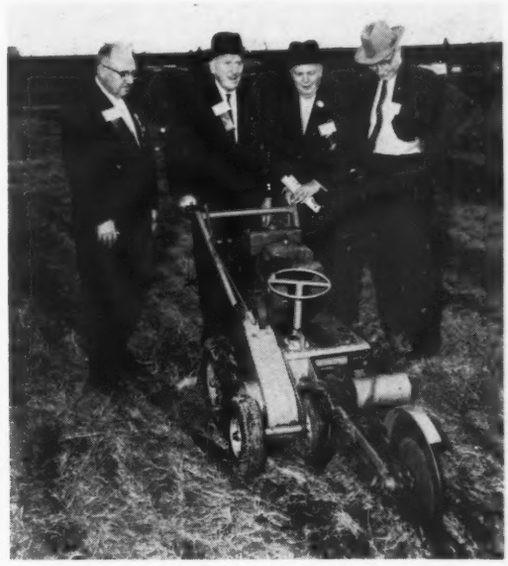
Details of fuel cell. ▸



Site of exhibit of modern tools for gas industry construction at 1959 A.G.A. Convention in Chicago was large area at Crawford Station of Peoples Gas Light and Coke Company.

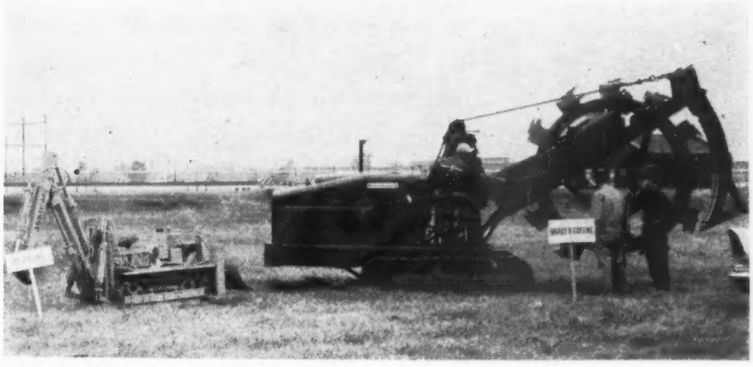
New Tools for Growth and Service

AGA's camera visits the 10-acre panoramic exhibit and equipment demonstration sponsored by the Operating Section during the 1959 A.G.A. annual convention in Chicago and reports to its readers on the latest in modern construction equipment for installing and maintaining gas distribution mains and services



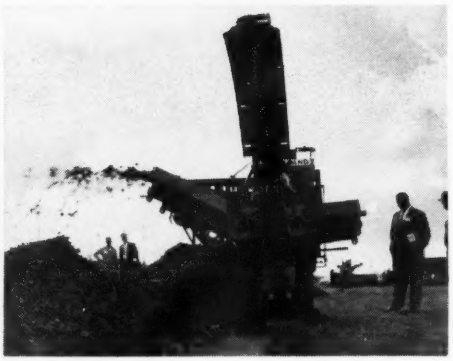
A.G.A. President J. Theodore Wolfe tries his hand, right, at digging a service line trench with a "Ditch Witch" slit trencher manufactured by Charles Machine Works. *For more data on this trencher, circle* **101** *on the Ready-Reply card at back in this issue.*

Contrast. Tiny but versatile "Agricat-Agrihoe" tractor with backhoe, ideal for service line work, is dwarfed by Barber-Greene Model 772 wheel-type trencher, designed for utility main ditching. *For more data on the Agrihoe, circle* **102** *on the reply card; for more data on Barber-Greene trenchers, circle* **103.**



"Hy-Hoe" truck-mounted Model 380 hydraulic backhoe has ⅜-cu yd capacity, easily reversible bucket, manufactured by Hydraulic Machinery Company. *For more data, circle* **104** *on the reply card.*

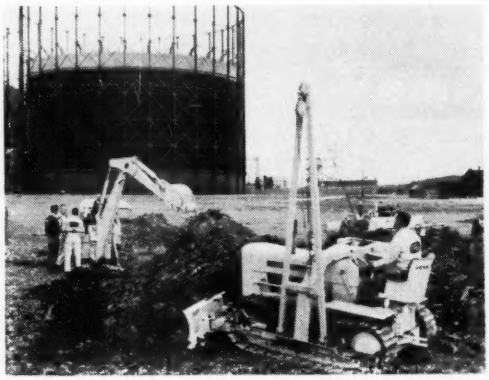
Attentive group of gas distribution men watch demonstration of Vermeer Manufacturing Company's POW-R-DITCHERS. *For more data, circle* **105** *on the Ready-Reply Card.*

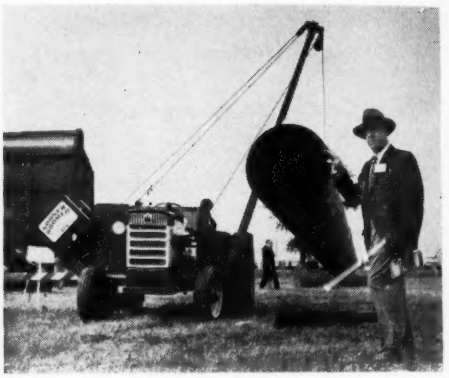


Dirt flies from Cleveland Trencher's Model JS-30 during demonstration of unit's lateral shifting arrangement and tilting wheel. *For more data, circle* **107.**

Left, above, Len Frazee of Greenhead Sling and Supply Company, demonstrates how one man can easily push pipe into casing using roller-bearing casing insulating spacers made by his company. *For more data, circle* **106.**

A pair of John Deere construction equipment units sized "just right" for gas distribution work. At left rear is wheel-type tractor with hydraulic backhoe; at right front is small track-type tractor with sideboom and backfiller blade. *For more data, circle* **108.**

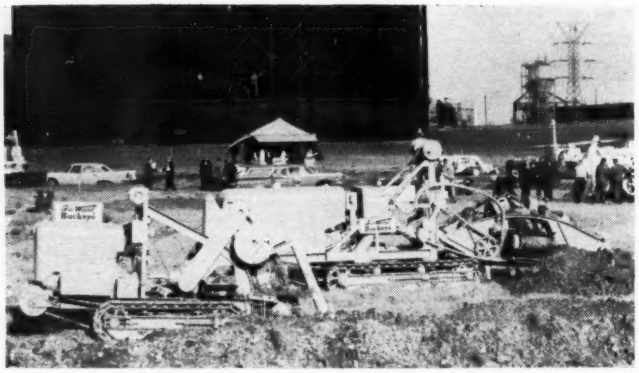




Above, right, American Gas Journal publisher Joe B. Woods examines "Sooner Boomer" sideboom mounted on International Harvester wheel-type utility tractor. Designed for distribution construction work, boom unit easily handles the 30-ft joint of 30-in. pipe as shown. *For more data, circle* **109.**

Thermite-welding method for making service line taps, called "Therm-O-Tap," drew many visitors to Continental Industries' display. *For more information, circle number* **111.**

Left, above, compact, front-mounted En-Arc rotary air compressor has 125 cfm capacity, extends only 20-in., uses power take-off drive from truck engine, and weighs less than 1000 lb. *For more data, circle number* **110.**



Two Gar Wood-Buckeye trenchers on display at exhibit include Model 303 utility ladder-type, at left, and larger Model 403 ladder-type trencher, at right. *For more data, circle number* **112.**

Parsons Company's Trenchliners on display at exhibit include Model 150 wheel-type trencher, at left, and Model 77 utility ladder-type trencher at right. *For more data, circle number* **113.**

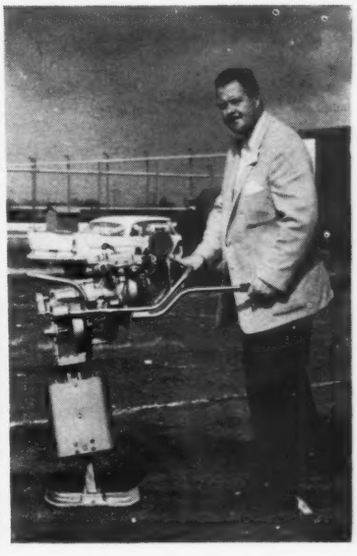
Hough Model 70-H Payloader tractor-shovel and attachments displayed at the exhibit included one unit, left photo, euqipped with a Wain-Roy hydraulic backhoe at one end and a Drott 4-in-1 bucket (combination shovel-clamshell-scraper-bulldozer).

In photo at right, unit equipped with front-end loader and Hough-Superior hydraulic telescoping sideboom demonstrates its lifting ability (capacity — 8750 lb at 4-ft overhang). *For additional data, circle number* **114.**

Paul Stentz of The Jay Company demonstrates new model J-18 "J-TAMP," a small gasoline engine driven compactor for tamping service line and small main backfill. *For more data, circle number* **115.**

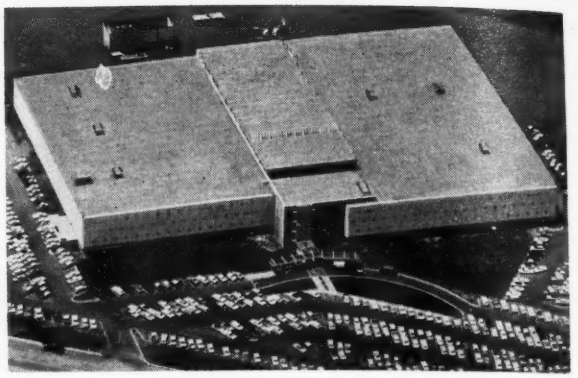
At right, high lift of Thompson Leveloder Model 3000 Van is graphically shown in photo. Larry Harper of Thompson Trailer Corporation is the smiling gent looking down. *For more data on the Leveloder, circle number* **116.**

Left photo, Chas. Spellman, product manager for Schramm, Inc., demonstrates latest model of Schramm's Pneumatractor equipped with a Rotadrill. *For more product data, circle number* **117.**



At right, George Christiansen of Racine Hydraulics and Machinery Company, demonstrates compacting ability of the RAPAK 3-hp gasoline powered tamper, which delivers 400 to 600 blows per minute, has interchangeable tamping shoes from 6 to 18-in. wide. *For more data, circle number* **118.**

SHOWCASE OF THE GAS INDUSTRY



Air view of Dallas Trade Mart.

Gas Appliance Center To Open In Dallas On January 2, 1960

IN THE VERY HEARTLAND OF THE NATURAL GAS INDUSTRY — the South and Southwest — where the highly competitive battle of the fuels is being waged between *all-gas* and *all-electric* interests, the gas industry is being offered an opportunity to put its "best foot forward."

On January 2, 1960, a new idea in merchandising gas appliances will be formally opened in the Dallas Trade Mart — the *Gas Appliance Center,* destined to be the "showcase of the gas industry." Three main components of the *Gas Appliance Center* will be telling the "all-gas" story — an industry display area, a general exhibit section for small manufacturers, and individual showrooms for larger manufacturers.

Purpose of the *Gas Appliance Center* is to display the modern wares of the gas industry to those groups who have the strongest influence on the buying habits of the public — dealers, builders, kitchen specialists, utility sales personnel, architects, developers, and related professional groups.

Space committments for the new *Center* have already been made by a number of leading gas appliance manufacturers — large and small — and these firms plan to begin decoration and arrangement of their showrooms and offices during December in time for the official opening in January.

Located in the giant 1,000,000 sq ft Dallas Trade Mart, at the edge of the Dallas skyline, the *Gas Appliance Center* will have a full-time staff that will provide an essential supplement to the sales forces of participating manufacturers. Broad scope, year-around promotional campaigns will be conducted by the Center, with the entire operation supervised by a group of experienced gas industry representatives.

Market Potential

The new *Gas Appliance Center* is intended to appeal to key buying groups of primary interest to the gas industry — and of special interest to manufacturers of gas appliances and equipment. These groups include:

- **Dealers** — whether they are owners of small appliance stores, appliance managers in large department stores, or buyers for multi-purpose businesses who must be concerned not only with appliances but also items such as lamps, toys, furniture, kitchen appliances, etc.

- **Builders** — who, as a group, hold the key to future growth of the gas industry in light of today's trend toward completely-equipped homes into which a family moves lock, stock, and barrel. In the builder, the gas industry faces its greatest challenge if it is to reach the new home market; to take the offensive in this battle, it must reach, sell, and keep the builder convinced.

- **Other important groups** — such as developers, architects, designers, kitchen and remodeling specialists, home economists, gas utility sales personnel, and the trade press. While many of these groups are not volume buyers, they represent very important factors in influencing the decisions of individual buyers. Their exposure to the "all-gas" center is expected to have significant effect on their attitude toward recommending gas or electric appliances.

Regional Market Importance

In recent years, the regional market has grown in importance to the manufacturer or wholesaler of such basic merchandise as appliances, furniture, home furnishings, housewares, gifts, and wearing apparel. No single city can any longer claim dominance as the buying center in any of these fields.

More and more dealers find it advantageous to visit regional markets and do their buying for a 6 or 12-month period direct from a manufacturer or his representative.

Simultaneously, closer alliances are being made with manufacturers by developers, builders, kitchen specialists, etc., and the "middleman" is being squeezed out as the pattern of distribution changes in our nation's marketing system.

Dallas has evolved as one of the principal regional markets in the U. S., and enjoys many advantages from a marketing standpoint — including its location near the geographical center of the Southwest, outstanding hotel and convention facilities, superior transportation facilities, all backed by a tremendous vitality and "civic personality."

The Dallas Trade Mart

Early in 1959, the Dallas Trade Mart opened its doors on 600,000 sq ft of exhibit space in a luxurious new building designed to accommodate only buyers, dealers, builders and other professionals. The general public is not admitted. The Trade Mart location is only five minutes from downtown Dallas via a new 14-lane expressway. Adjacent to the Trade Mart is the two-year-old Dallas Homefurnishings Mart (424,000 sq ft) occupied by more than 300 tenants. Nearby is the Decorative

Center, open to decorators, furniture buyers, and department store buyers. Under construction is a 300-unit motel, and soon to be built is a large Trade Arena for temporary exhibitors, conventions, and sales meetings. Projected for the future are a Builders' Supply Mart and a special mart for the apparel field.

The Trade Mart building is presently being expanded to 1,000,000 sq ft, and will be completed by January 1, 1960. The building now has more than 160 showrooms of 500 to 3000 sq ft in size. With the added new space, the Trade Mart will open an appliance section of some 60,000 sq ft devoted to radio, television, hi-fi, kitchen cabinets, and basic household appliances.

Open the year-around, the Trade Mart has already proved its success in "delivering the goods," evidenced by buyer registration of as much as 10,000 in one show week. Attendance continues to grow, and the geographical market area continues to widen.

Artist's sketch of entrance to the Gas Appliance Center.

Gas Appliance Center

Possibility of using the Trade Mart as a "showcase for the gas industry" was first conceived in mid-summer of 1959. When the idea was first presented to a limited number of executives from manufacturers, gas associations, and utilities, the response was unanimously favorable. Further discussions at the A.G.A. Convention in Chicago in October with some 25 manufacturers brought an enthusiastic reaction.

In mid-October, with this backing, a group of Dallas businessmen organized a private company known as Gas Industry Exhibitors, Inc., for the purpose of operating the proposed *Gas Appliance Center*. The company has leased a minimum of 20,000 sq ft in the Trade Mart Building, with space available for decorating in early December 1959, and formal opening of the *Gas Appliance Center* on January 2, 1960.

Approximately 2000 sq ft in the Center will be devoted to an industry display. Another 1500 sq ft will be used for a general exhibit area, where small manufacturers may lease as little as 49 sq ft. The remainder of the Center will be subdivided into separate booths, ranging in size from 525 to 1375 sq ft. A number of gas appliance manufacturers are expected to locate their regional or district offices in these showrooms.

The *Gas Appliance Center* will be open the year-around, and will have a full-time manager and a secretary-hostess, whose duties will include:

1. Promoting attendance;
2. Escorting visitors through the center;
3. Working with manufacturers in development of effective displays;
4. Arranging for industry exhibits, and
5. Otherwise assisting in making the Center a success.

Center personnel will not take orders for merchandise, but will arrange for contacts between interested buyers and manufacturers. Every visitor to the center will be registered and appropriate manufacturers notified of their attendance.

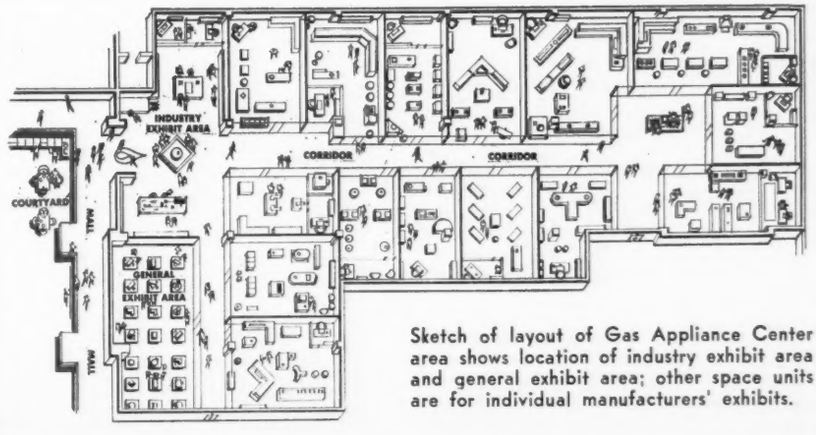
Space in the *Gas Appliance Center* is open to any reputable manufacturer of gas appliances and heating or air conditioning equipment — although no electrical appliances or equipment with a gas counterpart may be exhibited. All gas appliances or equipment to be shown must have A.G.A. approval.

Gas and electricity will be available in all the showrooms for operation and demonstration of appliances. A small auditorium is available in the Trade Mart Building at no charge for holding sales meetings.

The gas industry area will feature such displays as an all-gas kitchen and laundry room, heating and air conditioning equipment, and general industry exhibits related to gas distribution, transmission, production, research, etc. Promotional material on the industry will be available. All appliances or equipment used in industry exhibits will be limited to brands of manufacturers leasing space in the Center, and will be rotated on a fair and impartial basis.

Space in the Center is leased on a first-come, first-served basis.

For further information and details on services, costs, financing, and other aspects of the *Gas Appliance Center*, inquiries should be directed to David J. Kerr, Director of Business Development, Southern Union Gas Company, Burt Building, Dallas 1, Texas; Telephone RIverside 7-7541. * * *



Sketch of layout of Gas Appliance Center area shows location of industry exhibit area and general exhibit area; other space units are for individual manufacturers' exhibits.

AMERICAN GAS FUNDAMENTALS

Corrosion Notebook

Control of Corrosion and Leakage In Florida Distribution Systems

Joseph Frink, *Engineer, The Houston Corporation, St. Petersburg, Florida*

PERFECTION — to a gas distribution company corrosion engineer — would be an entirely new gas distribution system with good coatings, perfect insulating flanges and couplings, and a qualified corrosion engineer as inspector of installations made by contractors.

Because such perfection is seldom encountered, the corrosion engineer is usually confronted with controlling corrosion (leakage) in old cast iron systems interspersed with galvanized iron laterals and service lines. These systems present quite a problem and many gas distribution companies are still going through the complicacies of having two quite different types of systems combined into one; coated and wrapped steel vs bare cast iron and galvanized systems. In Florida, we are confronted by this problem.

Corrosion causes leakage, and corrosion control combats leakage in gas distribution systems; for this reason, corrosion and leakage control always go hand-in-hand and are definitely dependent one upon the other. The Houston Corporation has combined these two programs into one for its gas distribution properties in Miami, Jacksonville, Daytona Beach, Orlando, Umatilla, Mount Dora, Eustis and Lakeland.

In setting up this combination program, it was found that three corrosion technicians and helpers with a completely equipped truck for each would be able to accomplish these two phases with the assistance of the distribution departments in each city. A technician is stationed in each of the three major properties in Florida — Miami, Jacksonville, and Orlando. Each is responsible for corrosion mitigation and leakage control in his assigned territory and is under the direct supervision of the local superintendent of distribution. The technicians in the two larger cities, Miami and Jacksonville, work specifically in these two areas while the technician in Orlando is responsible for all other cities remaining in addition to his own home location.

Soil Resistivities

To gain an insight on the corrosion problems existing in Florida, one needs to know more about soil resistivities as found around the state.

Ideal soils exist near the center of Florida in the Lakeland, Orlando, Eustis, Mount Dora, and Umatilla areas. These soils are sandy with very few clay spots, and soil resistances in these areas will seldom drop below 10,000 ohms/cm with most soils ranging from 100,000 to 250,000 ohms/cm and higher. Even the lake waters in these sections seldom show resistances below 8000 ohms/cm.

Under these conditions it can be readily seen that steel pipe can be installed without coatings with very little danger of corrosion. There are, of course, some areas where resistivities drop below 10,000 ohms/cm and require special attention in the form of coatings and some anode installations. These conditions make it necessary that soil surveys be made for all main extensions and services in order that coatings and anode installations can be specified where found necessary. The author has had occasion to remove black iron pipe in these sections of Florida that has been in service for over 35 years and found it in such good condition that it could be placed back in stock for re-use.

Coastal Area Problems Serious

The soil picture radically changes as the coastal areas are approached. In the Miami area an almost solid coral rock sub-foundation is found. This coral is porous and allows tide-water to change soil resistances twice each day. In excavations, this rock is encountered about 18-in. below the surface and continues as far downward as you may excavate. This presents difficulties even in anode installations and test box locations.

In most sections the tidal water effect is below gas main levels and the soil (rock) resistances will be above the 10,000 ohms/cm level, but the "pot hole" area resistances may, at times, be as low as 50 ohms/cm and contain actual sea water.

Serious corrosion occurs in the low areas near the bay and rivers. Differential aeration always occurs at meter risers even on galvanized pipe and it is absolutely necessary that all pipe be coated at these particular points in all locations. All steel pipe in the Miami area requires coating and wrapping and, in most sections, requires an extra-heavy coating or rock-shielding due to the serious abrasion of the coral rock that must be used for back-fill.

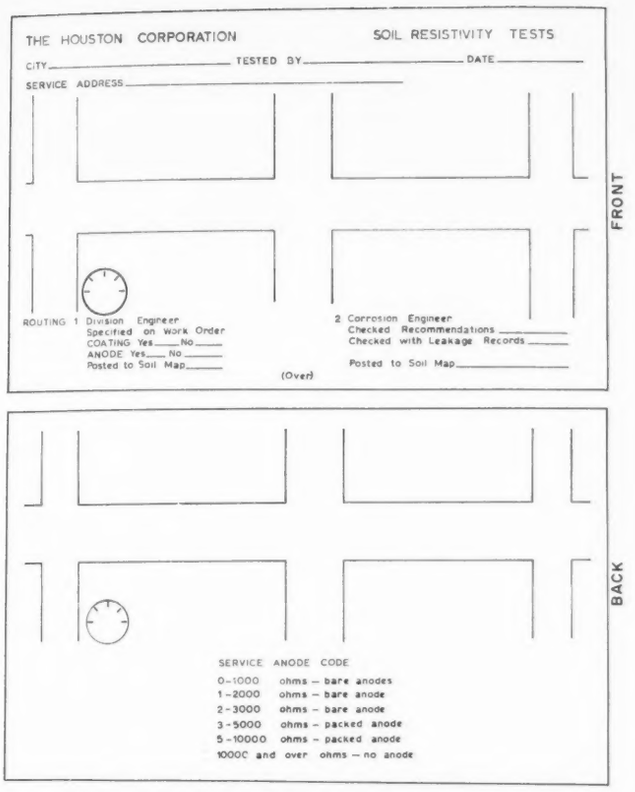
The Jacksonville and Daytona Beach areas each present additional soil condition problems and are quite different from that of Miami or the Central Florida portion. Daytona Beach has an underlying Coquina rock strata but it exists in sheets and gives little difficulties as compared to the coral formations in the Miami area. Sulfur water underlies this area as well as that of Jacksonville. Soil resistivities are relatively lower than in the Miami area, presenting additional problems in cathodic protection.

In the Jacksonville area, soil resistivities probably average 5000 to 6000 ohms/cm whereas the Miami area will average higher, but no soils in either Jacksonville or Daytona Beach have been encountered with resistivities as low as those in the "pot-hole" areas of Miami. The sandy formations in Datona Beach and Jacksonville areas will vary in resistance from one city block to another. Resistivities having been encountered range from 500 to 1000 ohms/cm in one block to 100,000 and above in the next two blocks. This presents additional problems in cathodic protection.

No Simple Solution Possible

The overall picture of soil conditions in Florida cities, when put together in one parcel, presents so many different approaches from a corrosion mitigation standpoint that no one method can be specified as a final approach, because each city has its own particular problems. In one area it is almost impossible to corrode a piece of bare steel pipe even with reversed forced currents, while in another area the same piece of pipe would not last six months.

The old cast iron and galvanized


THE HOUSTON CORPORATION SOIL RESISTIVITY TESTS

CITY _____ TESTED BY _____ DATE _____

SERVICE ADDRESS _____

FRONT

ROUTING: 1 Division Engineer
Specified on Work Order
COATING Yes ____ No ____
ANODE Yes ____ No ____
Posted to Soil Map ____

(Over)

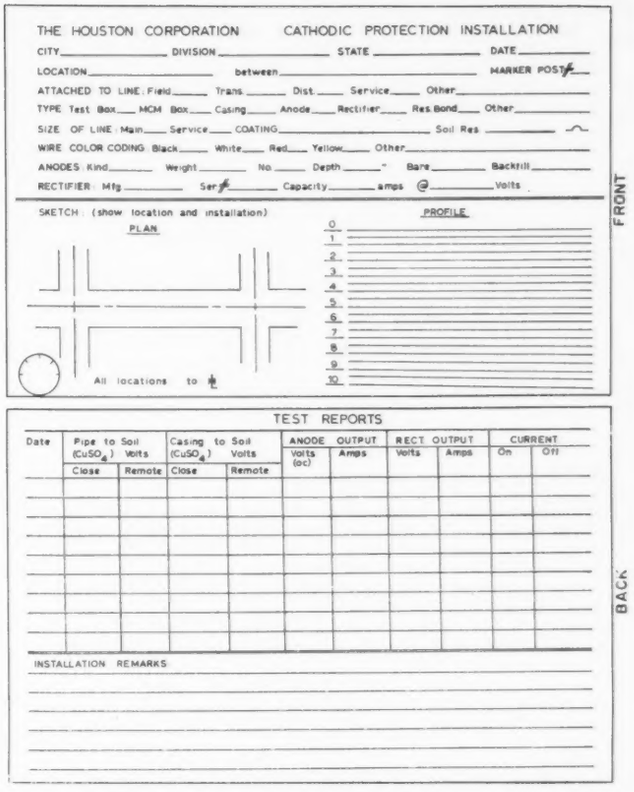
2 Corrosion Engineer
Checked Recommendations ____
Checked with Leakage Records ____
Posted to Soil Map ____

BACK

SERVICE ANODE CODE

0–1000 ohms – bare anodes
1–2000 ohms – bare anode
2–3000 ohms – bare anode
3–5000 ohms – packed anode
5–10000 ohms – packed anode
1000C and over ohms – no anode

FIG. 1. **"Soil Resistivity Test" card.** Color code (see text) is used to indicate soil resistivity on front side; on back, similar color code is used to indicate need for anode installation.


THE HOUSTON CORPORATION CATHODIC PROTECTION INSTALLATION

CITY _____ DIVISION _____ STATE _____ DATE _____

LOCATION _____ between _____ MARKER POST # _____

ATTACHED TO LINE: Field ____ Trans ____ Dist ____ Service ____ Other ____

TYPE Test Box ____ MCM Box ____ Casing ____ Anode ____ Rectifier ____ Res Bond ____ Other ____

SIZE OF LINE: Main ____ Service ____ COATING ____ Soil Res ____

WIRE COLOR CODING: Black ____ White ____ Red ____ Yellow ____ Other ____

ANODES: Kind ____ Weight ____ No ____ Depth ____" Bare ____ Backfill ____

RECTIFIER: Mfg ____ Ser # ____ Capacity ____ amps @ ____ volts

FRONT

SKETCH: (show location and installation)

PLAN

PROFILE

0 1 2 3 4 5 6 7 8 9 10

All locations to #

TEST REPORTS

Date	Pipe to Soil ($CuSO_4$) Volts		Casing to Soil ($CuSO_4$) Volts		ANODE OUTPUT		RECT OUTPUT		CURRENT	
	Close	Remote	Close	Remote	Volts (oc)	Amps	Volts	Amps	On	Off

INSTALLATION REMARKS

BACK

FIG. 2. **"Cathodic Protection Installation" card.** Detailed information on each test point, anode bed installation, insulating flange or coupling installation, rectifier installation, or anode installation on service lines is recorded on front side. On back, test reports are entered.

iron piping systems also present long-range problems for corrosion mitigation and leakage. These systems before the war were in good condition. Since that time the influx of new residents to all of Florida has necessitated vast additions to all underground utilities with the exception of gas piping.

Meter Insulation Protects Old Systems

With the coming of natural gas to Florida this year, we find the old main systems receiving more than their share of corrosion due to drainage currents from other systems. In order to alleviate this "current dumping" from these gas mains, it is necessary that these mains be isolated from the water systems (which carry all grounding systems in the cities). To accomplish this, all gas meter installation in both the old and new systems must be insulated at the meter inlet. This is costly and requires much time and effort, but it is an absolute necessity as it is actually the least expensive method of partial protection of the older systems as well as for the new systems. By using this isolation, it is estimated that approximately 60 percent of the present active corrosion on the older systems will be alleviated, thus requiring much less cathodic protection efforts on these mains than would be otherwise necessary.

Protection of New Mains

All new gas mains are being placed under cathodic protection in addition to protection by coating and wrapping. The only exceptions are those extremely high resistant locations in the Central Florida region, and even these will have "spot" wrapping and protection where necessary. Magnesium anodes, both packed and bare, are used for protection and are installed where tests indicate the necessity.

Soil Resistivity Records

Soil resistivity tests, as they are made, are recorded on our standard *"Soil Resistivity Test"* cards. These resistivities are posted on our area soil maps along streets shown. Postings are made in colors for future reference as to new services or additional mains. These color maps are also very useful in the control of leakage as a correlation. These maps are in each office of the division engineers as well as the office of the corrosion engineer.

Since no standard color scheme has been adopted by corrosion engineers, the following color coding is being used:

Soil Resistivity Code

0 —	1000 ohms/cm	RED
1 —	2000 ohms/cm	ORANGE
2 —	3000 ohms/cm	BLUE
3 —	5000 ohms/cm	BROWN
5 —	10,000 ohms/cm	GREEN
Over	10,000 ohms/cm	YELLOW

In order that the division engineer may know whether or not an anode is required for service installations, the following anode installation code was arranged:

Service Anode Installation Code

YELLOW — No anode necessary
GREEN — Anode sometimes necessary
BROWN — Anode necessary
BLUE — Anode necessary
ORANGE — Anode increasingly necessary
RED — Multiple anodes may be necessary

(For details consult Corrosion Engineer)

Specifications for Protection

The following code is also used for gas service extensions from the mains:

GAS SERVICE EXTENSIONS
NEW STEEL CONSTRUCTION
Do not insulate at mains.
Insulate at meter loop only.
OLD CONSTRUCTION
Insulate at main and at meter loops.

Three-pound anodes, both packed and bare, are used on services where required. As an aid in specifying necessity of anode installations on services the following code is printed on the back of each *"Soil Resistivity Test"* card:

Service Anode Code

0 —	1000 ohms/cm	— bare anodes
1 —	2000 ohms/cm	— bare anode
2 —	3000 ohms/cm	— bare anode
3 —	5000 ohms/cm	— packed anode
5 —	10,000 ohms/cm	— packed anode
Over	10,000 ohms/cm	— no anode

THE HOUSTON CORPORATION

CITY_____ BLK. NO._____ CARD NO._____

GAS LEAKAGE CONTROL TEST RECORD

(See Reverse Side for Test Location Points)

DATE	TEST LOC.	TEST LEL	TEST % GAS	BY	DATE	TEST LOC.	TEST LEL	TEST % GAS	BY	DATE	TEST LOC.	TEST LEL	TEST % GAS	BY

FRONT

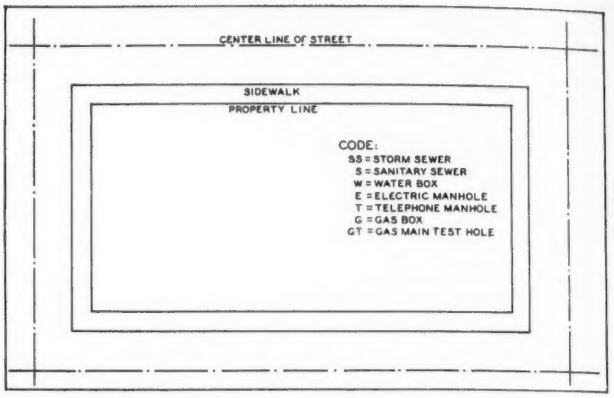


FIG. 3. **"Gas Leakage Control Test Record"** card. Data accumulated from leakage surveys is recorded on front of card; location of test points is entered on reverse side.

For main extensions, soil surveys are made prior to the installation of pipe and test boxes installed in low resistance locations that are suitable for anode bed installations, thus eliminating the necessity for re-excavations at the mains. These boxes are located in grass plots or unpaved areas when available.

In other locations, gas main anodes are installed close by the mains and attached to the gas service extension pipe as this pipe is directly welded to the main and acts as a perfect conductor for anode connection to the main. After the main is installed, pipe-to-soil potentials are made and the necessity for anodes determined and anodes installed. Anodes are, at times, installed as the pipe is installed where congested areas will not permit later installations.

All extensions of steel pipe from the existing cast or galvanized iron system require an insulating fitting. At each insulating fitting a test box (lightning arrestor type) is installed and wires brought into this box. With the following color coding we are able to easily distinguish all box wiring:

Color Coding for Wires in Boxes

Anode Wire — RED
Casing Wire — YELLOW
INSULATING FLANGES
North and West — WHITE
South and East — BLACK
TEST LEADS
Main Wire — 2 BLACK
IR Drop Wire — 2 BLACK
(one labeled with footage and direction)

On distribution mains, meter risers at houses are used for pipe-to-soil potential tests and are usually prolific enough to make any tests that may be necessary as the service is not insulated at the main and both are under the same protection. On high pressure supply mains it becomes necessary to install test boxes along the main for potential test readings since few if any services are run from these mains.

The *"Cathodic Protection Installation"* card is used for all test points, anode bed installations, insulating flanges or couplings, rectifier installations, and anode installations on service lines. These cards carry all pertinent information as to location, type main, size of main, wire color coding, anode information, rectifier information, etc., showing plan and profile of installation. The back of these cards are used for reporting tests as made in the future.

It would be financially impossible to place all parts of each existing cast iron or galvanized system under cathodic protection. With these systems, it is logical to place those sections under protection where soil resistance and leakage experience show the necessity — either from old records or future experiences. It is good practice, however, to bond each bell and spigot joint whenever accessible for any reason, and to insulate each service installed or replaced at both the main and at the meter loop, installing a small service anode where necessary. By using this bonding, the system will be partially ready for cathodic protection when necessary.

For the present, service line anode installations are being made by the technician and his helper when tests show the necessity. In this way one trip is eliminated and the contractor or installation crew is relieved of the chore of anode installations. The technician tests only soil resistivities after the services have been installed.

The larger gas main anode installations are now being contracted as they are so scattered over the state that it would be impractical to have an anode installation crew in each territory, and a roving anode crew would spend most of its time travelling between the distant cities.

Leakage Control Program

Leakage in gas mains is due principally to two factors — corrosion and drying joints. Gas mains in the older systems have, in many cases, corroded on the bottom side and are kept from leaking by the semi-solids deposited in these mains on the bottom of the pipe.

As dry natural gas flows through these mains the natural gas, which has the trait of absorbing oils and water, will take up the bonding oils from the semi-solids and render them powdery in form. When this happens the main begins to leak excessively and must be replaced. Mains that have thus corroded, when renewed, should be insulated from the existing system, and placed under protection.

The cast iron mains may not be quite as corroded as the old galvanized mains, but they sometimes will be found in this same condition. These cast iron mains will also begin to leak at the bell and spigot joints as the natural gas absorbs the oils or waters in the jute packings in these joints. Experience over the country has proved that this leakage reaches its peak in from three to four years after the introduction of natural gas into old systems. It becomes necessary, therefore, to begin the detection of these potential hazards while time will allow repairs to the old systems.

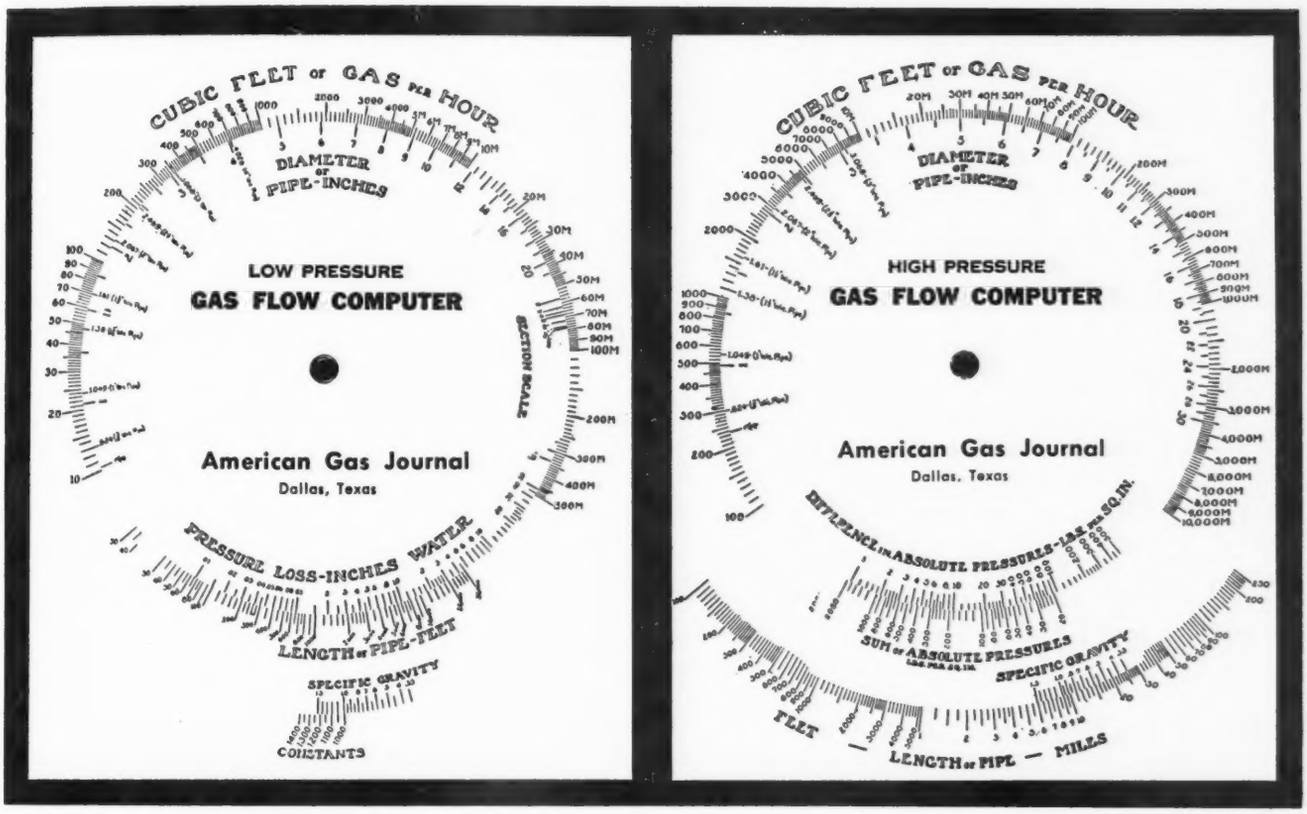
Leakage Surveying

Each technician's truck is equipped with leak detectors, impact probe bars, a small air compressor with rock drill, and plastic pavement inserts. In the downtown areas of each city these pavement inserts are installed along the gas mains for regular checks for leakage. In addition to these checks, block leakage surveys will be made of all manholes, water boxes, available valve boxes, etc., and this information is recorded for present and future reference. Our *Gas Leakage Control Test Record Card* is used for these checks.

Vegetation surveys have always been made by gas companies in the outlying areas where manholes and other openings are not available. With natural gas these surveys are not nearly as reliable as those that are made on manufactured gases. *The only appreciable effect that natural gas has upon vegetation is the drying out of the soil, thus causing the vegetation to wither due to lack of moisture, and considerable gas must escape before this drying out of the soil will take place to the extent of withering vegetation.*

Speed up your calculations on pipe sizing, pressure drop, flow with the American Gas Journal . . .

GAS FLOW COMPUTERS



For LOW Pressures

Cubic feet of gas per hour	*10 to 500M*
Pipe diameters	*¾-in. to 48-in.*
Pressure loss (inches)	*.01 to 50*
Specific gravities	*.35 to 1.5*
Constants	*1000 to 1400*
Pipe length (feet)	*30 to 30,000*

For HIGH Pressures

Cubic feet of gas per hour	*100 to 10,000M*
Pipe diameters	*¾-in. to 30-in.*
Difference in absolute pressure to	*500 psi.*
Sum of absolute pressures	*20 to 2,000 psi.*
Specific gravities	*.35 to 1.5*
Pipe length (feet)	*100 to 5,000*
Pipe lengths (miles)	*1 to 250*

The computers are printed on heavy durable plastic, enclosed in Fabrikoid cases with complete instructions for their use.

PRICE: $7.50 EACH

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AMERICAN GAS JOURNAL

P. O. BOX 1589 • DALLAS 21, TEXAS

There are a few valve-killing services where Rockwell-Nordstrom valves *do* fail—after outlasting non-lubricated valves by ten or twenty times. But on *most* services—when properly specified and properly maintained—they last as long as the installation of which they're a part. This is why: Rockwell-Nordstrom valves are *lubricated*. Pressurized lubricant in the Sealdport system does three things. 1) It creates a powerful leak-proof seal that can't be permanently damaged because it *renews itself*. 2) By hydraulically cushioning the plug, lubricant *prevents freezing and jamming*. 3) Lubricant protects every moving part against wearing *friction* and no vital part is exposed to the line. The lubri-

Lubrication makes the

cation largely eliminates the *causes* of valve failure. How much would you save if you had a valve that never needed to be replaced—or that outlasted your present valves by ten or twenty times? Try just *one* Rockwell-Nordstrom Valve on your toughest service. *Rockwell Manufacturing Co., Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Ltd.*

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

difference . . . . . .

THE HOUSTON CORPORATION
GAS LEAK AND REPAIR REPORT

CITY _____ DIVISION _____ STATE _____ Combustible Indicator Tests

STREET ADDRESS _____ L.E.L. _____ % GAS _____

TESTED BY _____ DATE _____ LEAK CLASSIFICATION _____

LEAK CLASSIFICATION CODE

A – Small quantity of gas found; little danger of hazardous condition.
B – Larger volume of gas found; little danger of hazardous condition.
C – Exceptionally large volume of gas or leak of any size creating hazardous condition which may involve loss of life or property damage. Requires immediate attention.

FRONT

Method of Detection: Trees _____ Shrubs _____ Grass _____ Weeds _____ Odor _____ Bar Hole _____

Leak appears to be at/on: Main _____ Service _____ Joint _____ Tee _____ Ell _____ Misc. _____

Cover: Concrete _____ Asphalt _____ Brick _____ Gravel _____ Soil _____ Grass _____ Parkway _____

Soil Resistance near Leak (ohms) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____

Cathodic Protection: MAIN Yes _____ No _____ SERVICE Yes _____ No _____

In Area:

SKETCH OF APPROXIMATE LOCATION OF LEAK

REMARKS: _____

(over)

BACK

REPAIR REPORT:

Pipe Diam. _____ In.; Depth _____ In.; Length Exposed _____ Ft.

Leak on: Top _____ Bottom _____ Side _____; Leak at: Threads _____ Coupling _____ Weld _____

Pipe Surface Area _____ Other (Describe) _____

Pipe Bare _____; or Coated _____; If Coated: Type _____

Condition: Excel. _____; Good _____; Fair _____; Poor _____

Soil Conditions: Sand _____; Clay _____; Loam _____; Other (Describe) _____

Moisture: Dry _____; Damp _____; Wet _____; Describe Nature of Corrosion and Pipe Condition _____

Repairs Made: _____

Repair Coating Type: Mastic _____; Hot Applied Tape _____; Other _____

Anodes Installed: How Many _____; Anode Weight _____ Lbs.; Depth Installed _____ In.
(Measured to Anode Top)

SKETCH OF REPAIRS MADE

REPAIRS MADE BY: _____

FOREMAN _____ DATE _____ SUPERVISOR _____ DATE _____

CORROSION CONTROL REPORT:

Pipe to Soil Potential (Copper/Copper Sulphate Electrode)

Main _____ v Service _____ v (close)

Main _____ v Service _____ v (remote)

Main under protection: Yes _____ No _____; Insulated at Main: Yes _____ No _____

Service under protection: Yes _____ No _____; Insulated at Meter: Yes _____ No _____

REMARKS: _____

TESTED BY _____ DATE _____

FIG. 4. Gas Leak and Repair Report. This form used to report locations of leaks and give details on repairs made. A "corrosion control report" is incorporated into the form for future use.

It, therefore, becomes necessary that regular bar-holes be made along the main to detect the smaller leaks. This is very time consuming and very soon turns into costly work.

A small conveyance is on the market that hydraulically punches a small hole in the soil or soft pavement, extracts a sample of the atmosphere by means of an aspirator through a leak detector and gives an immediate reading. This also is very slow as compared to the recently patented infra-red methane detector mounted as a mobile unit. This unit detects methane gas leaks as it moves along the mains at a speed not exceeding 6 miles per hour. This mobile unit is very costly and is not available commercially. Our company is investigating both of these detectors for use, but at present is using the block method of leakage surveys, with special attention being given to large buildings, schools, hospitals, and other important buildings.

Repairs

After the detection of leakage, repairs become necessary. These are usually made by excavations with replacement of mains where found necessary and repairs where possible. The latest methods of sealing gas mains under internal pressure are proving less costly because of their speed and permanency.

The *"Gas Leak and Repair Report"* form is used to report locations of leaks and repairs made. Into this report has been incorporated corrosion information for future leak records and main replacements as leaks re-occur.

All leaks are plotted on transparent overlays for system maps, the corrosion leaks being dotted in RED while the dried-out joints are plotted in BLUE. When this overlay is spread out on a system map, leakage can be readily observed over the entire system and can be separated as to causes of leakage. By this method we are able to determine whether corrosion is causing the leaks and the main is ready for replacement — or whether the dried-out joints will require either leak clamps or other methods of sealing.

Corrosion control on old cast iron and galvanized iron systems will not present any great problem if the above plan is followed. Leakage control, on the other hand, can become increasingly serious as the time element advances. Steps should be taken to do everything possible to foresee this stupendous problem and take the necessary steps before it becomes "too late."

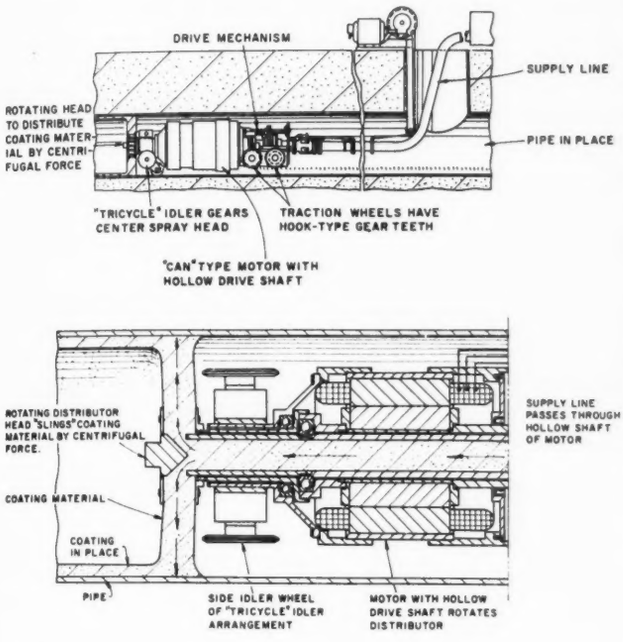
Acknowledgment

This article prepared from a presentation made at the 1959 annual Florida-Georgia Gas Association meeting, St. Petersburg, Florida.

* * *

PATENT REVIEW

NEW IDEAS FOR THE GAS INDUSTRY

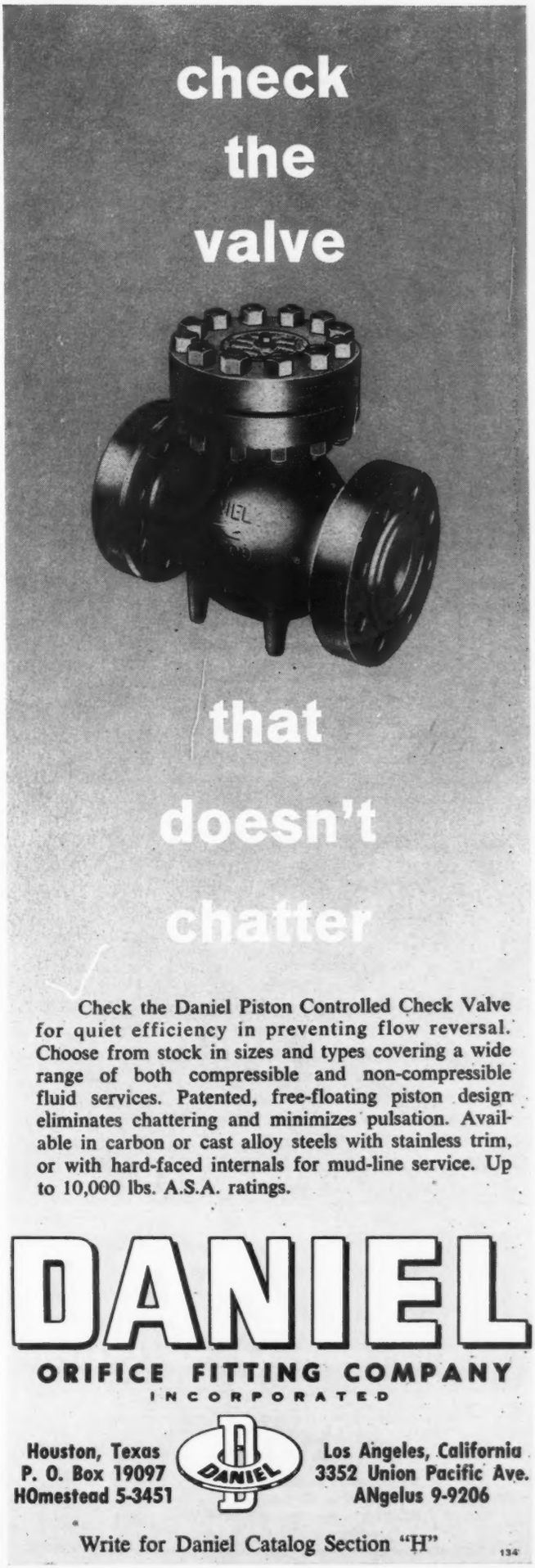

DRIVE MECHANISM
SUPPLY LINE
ROTATING HEAD TO DISTRIBUTE COATING MATERIAL BY CENTRIFUGAL FORCE
PIPE IN PLACE
"TRICYCLE" IDLER GEARS CENTER SPRAY HEAD
TRACTION WHEELS HAVE HOOK-TYPE GEAR TEETH
"CAN" TYPE MOTOR WITH HOLLOW DRIVE SHAFT
ROTATING DISTRIBUTOR HEAD "SLINGS" COATING MATERIAL BY CENTRIFUGAL FORCE.
SUPPLY LINE PASSES THROUGH HOLLOW SHAFT OF MOTOR
COATING MATERIAL
COATING IN PLACE
PIPE
SIDE IDLER WHEEL OF "TRICYCLE" IDLER ARRANGEMENT
MOTOR WITH HOLLOW DRIVE SHAFT ROTATES DISTRIBUTOR

Improved Self-Propelled Machine Internally Coats Pipe In Place

Improved machine for applying a protective coating by centrifugal force to the inner walls of relatively small diameter (12-in. or smaller) mains has been patented. The self-propelled coating machine is rugged and powerful enough to drag long lengths of the coating supply hose (up to 1000 ft) into the pipe that is to be lined. Basically, the machine consists of a distributor head rotor adapted to apply the coating to the pipe walls by centrifugal force, an electric motor having a hollow drive shaft (through which the coating supply line passes) that propels the machine into the pipe and provides reverse propulsion on the return trip while applying the coating. The motor drives two sets of wheels that have hook-like teeth set to engage the pipe wall. (Fig. 1). The protective coating is pumped to the machine through a hose that can be pulled into the pipe by the machine; the supply hose is withdrawn under tension in advance of the coating machine on its return trip. *U. S. Patent 2,892,444 (1950) June 30. Pipe Lining Apparatus, Alfred J. Perkins, Warsaw, New York, assigned to Perkins Pipe Linings, Inc. Grand Island, New York, a corporation of New York.*

Alkyl Thioethers Used as Sulfide-Type Odorants for Gas

Use of the alkyl thioethers containing at least one tertiary alkyl group as odorants for natural, manufactured, or mixed gas has been patented recently. Gas odorants in current use belong to the general category either of mercaptans or organic sulfides. The alkyl thioethers containing a tertiary alkyl group are used as sulfide-type odorants and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Patent Review

possess the oxidation stability common to thioethers and a higher odor intensity than other alkyl thioethers. Among the compounds useful as odorants in accordance with the patent are tertiary butyl, methyl, ethyl, propyl, and isopropyl sulfides, and tertiary amyl, methyl, ethyl, propyl, and isopropyl sulfides. Other compounds of this type may also be employed; the alkyl chain length being limited only by the vapor pressure of the compounds, i. e., the compounds must have a vapor pressure sufficiently high so that the compound may be vaporized into the gas stream in amounts sufficient for adequate odorization. It is also essential that a tertiary carbon atom be directly linked to the sulfur atom. Engler distillation of tertiary butyl isopropyl sulfide was as follows: Initial BP—37.0; @ 95%—135 and FBP—141 C. Distillation of the tertiary amyl ethyl sulfide was: IBP—35.0; 95%—159; and FBP—163 C. Specific gravity of tertiary butyl isopropyl sulfide is 0.815; of tertiary amyl ethyl sulfide, 0.840. Recommended odorizing rate for odorants of this group is 0.2 to 3 lb per MMcf. *U. S. Patent 2,872,304, (1950) Feb. 3. John L. Eaton, Whitemarsh, Pennsylvania, and George E. Hinds, Houston, Texas, assigned to Pennsalt Chemicals Corporation, a corporation of Pennsylvania.*

Copies of the patents reviewed briefly in this feature may be obtained for 25 cents each (remittance with the order) from the Commissioner of Patents, Washington 25, D. C.

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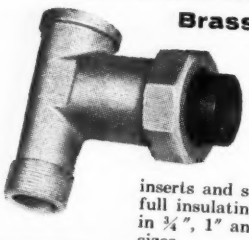

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DISTRIBUTION DEVELOPMENTS

NEWS ABOUT CURRENT AND PLANNED CONSTRUCTION

The Gas Service Company, Kansas City, Kansas, has construction underway on a new natural gas distribution system to serve Lake Quivira, Kansas, located 12 miles from Kansas City and 8 miles from Mission. Approximately 34,000 ft of various size pipe will loop the lake to serve 160 residential customers. Clubhouse for Quivira Country Club previously used gas as a main line customer of Cities Service Gas Company; however, no gas service was available for residences at the lake. Approximately 2135 ft of 8-in. has been installed to replace a 6-in. main at Carthage, Missouri, at an estimated cost of $19,000. Line was laid along Lyon Street and has two low pressure regulator tie-ins. Work was done by contractor crews. In Kansas City, Missouri, company crews installed 16,000 ft of 20-in. cross town intermediate pressure line along 33rd Street from Cleveland to Flora, to replace another 20-in. line on Linwood Boulevard. The line was moved to 33rd Street to avoid digging up the heavily traveled Linwood Boulevard. Two new telemetering circuits have been installed to connect the Independence, Missouri, plant at 23rd Street and Pleasant to the newly-established town border station at Bannister and Grogger and Craig and Hornbuckle Roads. The new telemetering facilities permit the company to control the pressure in the entire Independence distribution system by remote control from the plant.

Minnesota Valley Natural Gas Company, St. Peter, Minnesota, is constructing new distribution systems and extensions to certain existing systems in 30 cities and towns in upper Minnesota. Construction on an undetermined amount of distribution main extensions is underway in Brainerd and Little Falls. Engineering Construction Co. of Tulsa, Oklahoma, is contractor for the projects.

Niagara Mohawk Power Company, Syracuse, New York, has construction underway on an undetermined amount of 2 thru 20-in. gas distribution main extensions in Syracuse and Utica, New York. Contractor is C. N. Flagg & Co., Inc. of Meriden, Connecticut. Company recently completed a 17.5 mile 12-in. supply line extension north of Watertown, New York. Fulghum Contracting Corp. of Harrisburg, Pennsylvania, was the contractor. Company has pending before the New York PSC a proposal to construct a 122-mile 12-in. supply line to bring natural gas service to Ogdensburg, Massena, and other communities in northern New York. Additional gas supplies would come from New York State Natural Gas Corporation. Company has also installed pipeline facilities under the Iroquois lock at the St. Lawrence Seaway to augment its system supply if Canadian gas becomes available. A rival plan to serve parts of the northern area has also been presented by St. Lawrence Gas Co., Inc., an affiliate of Consumers' Gas Co., Toronto, Canada. Hearings on the proposals are currently being heard by the FPC.

New York State Electric & Gas Corporation, Ithaca, New York, has construction underway on an undetermined amount of 2 through 20-in. main extensions and new services in Auburn, and Lockport, New York. C. N. Flagg & Co., Inc. is contractor on the projects.

The Houston Corporation, St. Petersburg, Florida, has construction underway on an undetermined amount of 4 through 12-in. gas mains in the city of St. Petersburg. General Builders, Inc. of Jackson, Mississippi, is contractor on the project. In the city of Jacksonville, Florida, 30,000 ft of 6 through 12-in. lines from the outskirts of town into the center have been installed, and work is underway on approximately 150 miles of 2 through 12-in. natural gas distribution lines in the city. Completion date is set for early December. Contractor is Don W. Miller of Green Springs, Ohio. In Panama City, Florida, approximately 31 miles of 6 and 8-in. main lines were installed recently by crews of Harbert Construction Co. of Birmingham, Alabama, contractor. Company plans to spend approximately $23,000,000 during the next three years for expansion of distribution systems along its $200,000,000 Texas-Florida line.

California Pacific Utilities Company, San Francisco, California, has construction underway on an undetermined amount of 1, 2, and 4-in. main line extensions and gas services in La Grande, Oregon. Contractor is D. B. S. Pipeline Construction Co. of Tulsa, Oklahoma.

Montana-Dakota Utilities Company, Minneapolis, Minnesota, has completed a 15.5 mile 6-in. gas supply line in Valley County, Montana, and a meter and regulator station to serve the Glasgow Air Force Base. Construction on the gas distribution system (an undetermined amount of 6-in. lines on the base) is nearing completion. Contractor on the Air Force base construction is Abercrombie Construction Co. of Cut Bank, Montana.

Houston Natural Gas Corporation, Houston, Texas, has replaced approximately 19,000 ft of 8-in. main, 13,000 ft of 4-in., and 1100 of 2-in. along U. S. Highway 75 to improve pressure conditions in the Aldine area of northern Houston. In the Richmond district, both the Katy and Missouri City-Stafford main line systems have been extended; a new city gate station has been built at Stafford Oaks. The new station serves the Lypta Co., a manufacturer of cranes, and approximately 25 residential customers. A new distribution system has been installed in Edroy, 101st community to be served by Houston Natural; system receives its gas from a tap off Houston Pipe Line's Odem 18-in. line. System includes two new district regulator stations, and a Houston Natural-Houston Pipeline city-gate station.

Southern Union Gas Company, Dallas, Texas, has construction underway on an undetermined amount of main gas line in the vicinity of Albuquerque, New Mexico. Thompson Trenching and Pipe Line Construction Co., of Albuquerque, has the contract. During the past year, Southern Union has extended its pipeline supply system to bring natural gas to Tularos, New Mexico. More than $225,000 was spent to construct a 13-mile 6-in. supply line from Alamogordo to Tularosa and several miles of 4 and 2-in. distribution lines throughout the city.

Michigan Gas Utilities Company, Coldwater, Michigan, is currently installing approximately 200,000 ft of 2, 3, 4, 6 and 8-in. natural gas mains in Coldwater, Michigan, and approximately 150,000 ft of 2, 3, 4 and 6-in. gas lines in Three Rivers, Michigan. Contractor on the two projects is Van Orden & Van Ess Co. of Grand Rapids, Michigan.

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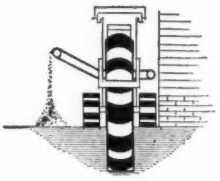

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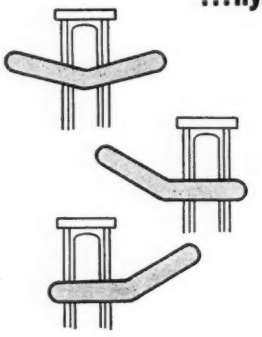

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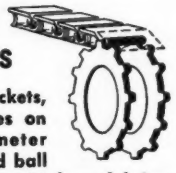

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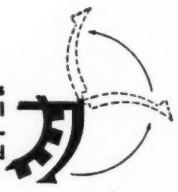

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Distribution Developments

Milwaukee Gas Light Company, Milwaukee, Wisconsin, is installing 7 miles of 16-in. gas distribution mains within the city of Milwaukee. Work is being handled by contractor crews of Dean Co. of Milwaukee.

Arkansas Western Gas Company, Fayetteville, Arkansas, has started testing operations of its underground storage project at the Rhea Bryan No. 1 well near Batavia. The project, thought to be the first of its kind in Arkansas, includes injection of gas in the Gunter water bearing sand. Several projects of this type have been successful in other states. The storage project will augment Arkansas Western's natural gas supply to Harrison, Berryville, Green Forest, and Eureka Springs areas. To date a 300 hp compressor has been installed at the storage site and approximately 2,500,000 cu ft of gas is being injected daily. Over 100,000,000 cu ft of gas has been placed in the sand at this time. Testing of the storage structure will continue for some time to come. Ultimate capacity is estimated at more than 5 billion cu ft. Cost of the project to date exceeds $200,000; $130,000 was budgeted in 1959 for the storage project.

New Orleans Public Service Company, New Orleans, Louisiana, has completed a renewal installation of 2100 ft of 8-in. intermediate-pressure steel main from a 12-in. main on South Saratoga Street to the Baptist Hospital along Jena Street. Work was done by company crews under supervision of foreman John Casebonne.

Louisville Gas and Electric Company, Louisville, Kentucky, is installing approximately 7 miles of gas distribution main extensions and new services in Ft. Knox, Kentucky. Work is being done by A. P. Wright Trenching Contractor of Louisville. New distribution systems have been installed recently in Simpsonville and Hodgenville, Kentucky, and a new measurement station constructed on Stonestree Road. The Hodgenville system consists of 2, 4, and 8-in. mains of medium pressure (10 psi); contractor was Memphis Pipeline Co. Louisville Gas has also completed its Magnolia storage field facilities. Approximately $6,000,000 has been spent to date to develop the storage field located about 50 miles south of Louisville. New facilities will enable the company to increase its storage to around 8 billion cu ft.

City of Duluth Water, Gas & Sewage Treatment Department, Duluth, Minnesota, has completed construction on 10.5 miles of 10 and 16-in. gas main extensions in Duluth. Contractor on the project was Somerville Construction Co. of Ada, Michigan.

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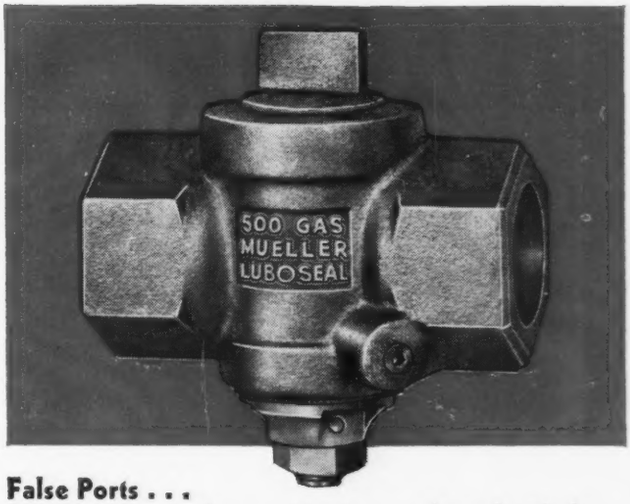

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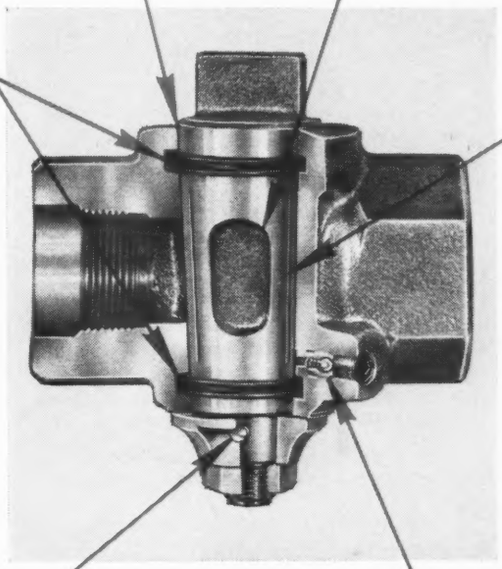
Ductile iron has excellent machining qualities, therefore the body and key can be accurately machined and **individually** ground and lapped for a precision, gas-tight fit.

False Ports...
False ports in the key and body are aligned with the true ports in the body and key when the stop is in the closed position. This prevents grit or dust in the gas from settling upon the polished sealing surfaces and later damaging them when the key is turned to open the stop. Seating contact is reduced to only those areas where it is useful, resulting in an easier turning stop.

Quad-Ring Seals...
Top and bottom of the key are positively sealed by quad-rings located in annular grooves in the stop body. The quad-rings also pressurize the lubricant — deflecting as the lubricant reservoir is filled and expanding to keep pressure on the lubricant as it is used.



Lubricated Key For Easy Turning and Pressure Tightness...
The lubrication system of LubOseal Stops maintains a proper grease film on the seating surfaces, assuring easy turning and pressure tightness. Four vertical grooves in the key distribute the lubricant over the ground and lapped surfaces each time the stop is operated. The quad-rings in the circular grooves and the entire seating surface between these grooves are fully lubricated. In any position other than fully "opened" or fully "closed", the vertical grooves are disconnected from the circular reservoir grooves, preventing the line pressure from forcing the grease out of the lubricant system.

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The grease port is located so that a ground and lapped seating surface is between it and the main gas port, preventing any leakage. A spring loaded, ball-check grease fitting provides a second seal. The socket head pipe plug forces grease through the grease fitting into the entire lubricating system and provides a third and final seal!

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How To Reduce Employee "Turnover"

Ernest W. Fair

How much does it cost the average gas company to locate, hire, and train any new employee—whether that individual works in the office, or the field, or elsewhere? The amount, of course, varies with each firm's method of doing business, but one recent survey showed that such costs, on an average ran from $175 to $350.

Where a firm loses two or three people a month, the turnover costs quickly amount to a sizable figure. Add to it, the costs of doing things over, correcting mistakes made by inexperienced employees, etc., and the figure mounts even higher.

Can anything be done to cut down such employee turnover in the average firm? Many alert executives are taking a number of measures to bring about a reduction. Here are some that can be adapted to every type and size of business.

● **Anticipate turnover possibilities and create a reserve of potential employees** so that costs of searching and interviewing can be reduced. If we know where the next man is coming from, searching and interviewing costs can be kept to the minimum. Having sources of qualified people always at hand and keeping such a list fresh and alive is a must. It is done by interviewing and prospecting for good new employees **before** the emergency arises, not after it occurs.

● **Use employment agencies for preliminary screening of prospective new employees.** Maintaining active contacts with such firms throughout your business area can prove of exceptional value if the people in charge have a clear understanding of exactly the type personnel the gas company desires. The agency should be notified that no further contacts will be made if these standards are not followed. Merely calling on such firms—without any previous outline of needs seldom utilizes their facilities to the fullest extent.

● **Establish the definite qualities desired of a typical employee and adhere to them.** Without such a list to go by, it is not easy to select the right individual, and particularly so when the executive is in a big hurry to secure a replacement. The establishment of such standards also makes it easier for employees to help locate new people, and it assures a more stable staff. Keeping the wrong person off the company payroll always helps reduce turnover.

● **Poor selection at hiring time** is always a major contributory factor to excessive turnover of employees in any business. This usually occurs with the sudden departure of one individual and the speedy hiring of just any likely man or woman to take his place. No amount of immediate need ever justifies lax selection methods or procedures; it only encourages personnel turnover.

● **Inadequate employee testing procedures** during the initial employment period is also the cause of a great deal of turnover in all types of business. (Gas companies are no exception.) Watching the first efforts of a new employee, seeing that they are satisfactory, and then accepting him or her without any further check very often adds just one more individual to the great "turnover group" existing today.

● Another prevalent contributing factor to excessive turnover is **failure on the part of management to keep a specific check on why that firm does have too much turnover among employees.** Attributing this to any generalized factor can often fail to bring out the true causes which, if discovered, may make the problem of employee turnover a minor one.

● **Early "screening-out" of the type of people you do not want in your company can help reduce later turnover.** It never pays to "put up with" an objectionable individual because there is no other immediate replacement available. Regular turnover will always be kept down by having the patience to find the "right" individual in the first place.

● **Maintaining harmony in the employee group** also helps reduce turnover. Make certain, when hiring a new individual, that the person will fit into the present staff. This can eliminate the possible need for a replacement at a later time and also the resulting disharmony brought about by resignations of other personnel on the staff.

● **Absolutely impartial and fair policies in handling every employee relationship** are most necessary. Sometimes it even pays to lean over backward to make certain that this is done.

● **Keep pay scales and working requirements in conformity with those established by competitors.** This is another must in holding down employee turnover. Where pay scales are below that of competition, you can always expect the best people on your staff to be constantly searching for a better paying job. The same thing applies to working requirements. No executive can ever expect to have a stable staff where working requirements are out of line with those of his competition or other lines of business in his area.

● **Demonstration of respect for one's employees with customers** is another sound policy to follow in any effort to keep employee turnover down. Employees are most conscious of what the customers of a business think of them as individuals; if management takes positive steps to keep this viewpoint "good," then this additional cause of employee turnover is removed.

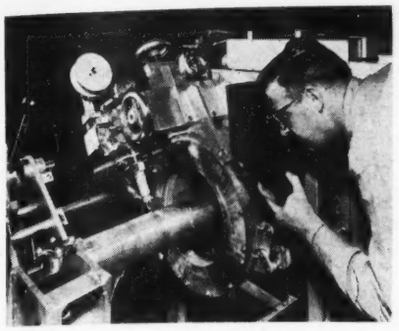
● **Guaranteed security of continued employment** has always been, and will always be, a major reason why people stay on the payroll of a given firm. An occasional emphasis of this condition does no harm whatsoever.

● **The right type of supervisory personnel** is always necessary. Check-up of specific firms where turnover has been great brought to light, that the wrong type of supervisory personnel was the sole reason for employee turnover.

● **Company policies which make employees proud of a firm** — not ashamed of it — always help to hold a good staff together. * * *

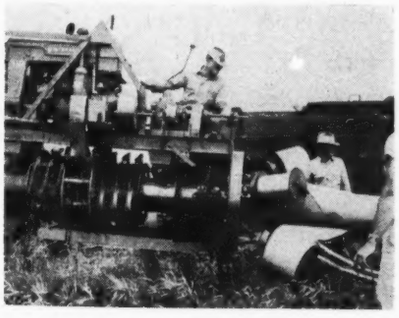
PRODUCT PARADE

MATERIALS – EQUIPMENT – SERVICES



AUTOMATIC PIPE WELDING MACHINES, designed and developed by Aluminum Co. of America, is capable of producing sound welds with full penetration without the use of back-up rings. High speed unit completes a pass on 4-in. pipe in 11 seconds, or 8-in. pipe in just 17 seconds. Head can be positioned through a wide range of welding angles. It can also be set to oscillate, automatically moving back and forth across weld width to insure complete filling. Torch can be tilted away from its welding position for fast servicing, without disturbing pipe in the machine. Finely regulated motor permits good speed control of wire feed and head rotation. New welder can process all tubular products with outside diameters of from 4 to 11 in. Electronic tubes, chronic trouble source in previous automatic units, have been replaced by magnetic amplifiers and semi-conductors. Vapor-proof cabinets, containing all electrical controls, are locked to guard against damage.

CIRCLE (1) ON THE REPLY CARD



COMBINATION CLEANING, COATING, AND WRAPPING MACHINE developed by Crutcher-Rolfs-Cummings, Inc. utilizes counter-rotating cleaning heads, coating shoe, and a revolving wrapping head in one compact unit. The combination line travel machine handles work formerly requiring 2 machines, (cleaning-priming and coating-wrapping machines), extra side booms, and cradles as well as labor. Tandem drive crawler wheels are standard equipment on all larger machines. Unit can be used as a cleaning and tape wrapping machine with adhesive type tapes, or it may be furnished with a coating shoe and used as a cleaning, coating and wrapping machine. Combination machines are available to handle pipe from 3 to 36-in. in diameter.

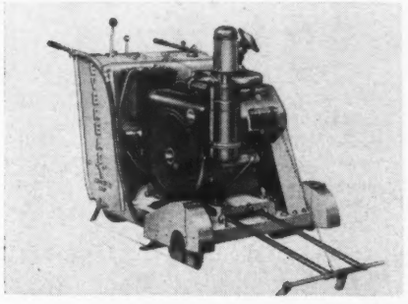
CIRCLE (2) ON THE REPLY CARD

NEW ELECTRONIC DEVICE manufactured by Carter Electronics Corp. of Dallas, allows operator of a private 2-way radio to talk from a mobile unit into any public telephone service–local or long distance. Known as "Carterfone," the device is entirely automatic—the speaker's voice places the base station transmitter on the air. Unit doesn't require a vehicle installation as one Carterfone at the base control station serves every mobile unit on the system. Unit is 100 percent transistorized, and does not require switching off and on from transmitting to receiving. In effect, the Carterfone places a telephone in each 2-way radio equipped vehicle. This is how it's done: A telephone contact is established between the operator of a base station and any party with available public telephone service. The telephone handset at the base station is then placed in the specially designed Carterfone cradle. And from then on broadcasting and receiving operations of the station are entirely automatic.

CIRCLE (3) ON THE REPLY CARD

COMBUSTIBLE GAS ANALYZER. New low-priced battery-powered gas detector designed to distinguish natural and manufactured gas from soil gas, liquid petroleum gas, and petroleum vapors by component analysis is now available from Gas Purifying Materials Co., Inc. The portable unit, called Anal-o-graph, allows field or remote location operation. In addition to qualitative analysis, accurate quantitative analyses are possible when constant temperature conditions exist.

CIRCLE (4) ON THE REPLY CARD



NEW 36 HP CONCRETE SAW designed for faster more accurate sawing, has been introduced by The Eveready BrikSaw Co. of Kansas City, Missouri. Unit features a new rear drive wheel design—the abrasive-coated transmission drive wheels which formerly created a friction drive with the rear wheels of the machine now have separate contact wheels which never touch the pavement. This eliminates clogging of the abrasive-coated wheels with the curing compound. Unit also has automatic blade control–a hydraulic pump lifts the blade out of the cut, thus eliminating hand pumping.

CIRCLE (5) ON THE REPLY CARD

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PRODUCT PARADE

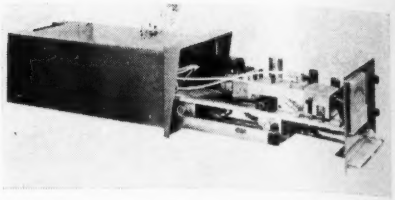
NEW PIPE COATING. Shell Chemical Corp. has developed a new low-cost Epon resin-bitumen coating especially suited for use as a corrosion resistant coating for pipe and other metal equipment. The new coating, based on Epon 828 and Bitumen C, a compatibilized bitumen which Shell Chemical will market, has greater chemical resistance than existing epoxy-coal tar enamels. The new high solids coating is suggested for use as a one-coat, inexpensive maintenance coating, and on the inside and outside of pipe.

CIRCLE (6) ON THE REPLY CARD

DIESEL-ENGINE-DRIVEN WELDERS. A. O. Smith Corp.'s new 300 and 400 amp, direct-current diesel-engine-driven arc welders allow the welding voltage to be adjusted automatically during use. Only 2 indicators have to be set to operate either unit—one for electrode size, the other for desired current. Both self-contained welders feature curves that remain steady even at extreme ends of range. Flattening out of peaks allows deep penetration without burnthrough. Welding range of the 300-amp machine is 60 amp minimum at 20 v, and 375 maximum amp at 40 v. Welding range of the 400 amp machine is 80 amp at 20 v, and 500 maximum amp at 40 v. Maximum open circuit voltage is 80. Units are powered by Continental liquid-cooled diesel engines.

CIRCLE (7) ON THE REPLY CARD

NEW PORTABLE INFRARED ANALYZER has been developed by engineers of Mine Safety Appliances Co. to provide faster, more flexible application

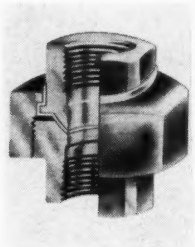


in the measurement of gases and vapors in atmospheres. Designed for application where moderately-priced instrumentation is required, the M-S-A LIRA analyzer weighs only 30 lb, and is housed in a compact case measuring 8 in. in height and width, and 19 in. in length. Compactness and light weight permit rapid transfer of the instrument between selected test areas. Unit can be calibrated for measurement from 0 to 100 percent of the lower explosion limit of natural gas; 0 to 1 percent total hydrocarbons in combustion control, and 1 to 50 percent relative humidity in humidity measurement of process streams.

CIRCLE (8) ON THE REPLY CARD

UNITIZED VALVE MANIFOLD to take the place of the conventional piped-up 5-valve manifold, has been introduced by Anderson, Greenwood and Co. Unit contains 2 main line shutoff valves, a double block equalizer valve, and an atmospheric vent valve—all in a single compact barstock body. All valves use replaceable soft seats to assure tight shut-off and long life. Although light in weight, unit is rated for 5000 psig and 200 F. An installation using the M6 manifold has approximately 13 less threaded connections than an equivalent fabricated manifold.

CIRCLE (9) ON THE REPLY CARD



INSULATED UNIONS. Complete line of insulated unions from ¼ through 2-in. in 150 lb malleable iron and 3000 lb forged steel pressures are now available from Central Plastics Distributing Co. Nylon insulation is molded and bonded directly to the unions eliminating any component parts.

CIRCLE (10) ON THE REPLY CARD

IMPROVED VINYL-BUTYL-LAMINATED PIPEWRAPPING TAPE developed by West American Rubber Co. combines advantages of a heavy mastic layer of butyl with a tough outer cover of vinyl. Butyl compound provides a permanent seal that fills all pits, prevents moisture migration at the overlap, and also provides a shock-absorbing cushion to lessen the possibility of cuts or tears. Vinyl backing provides a maximum resistance to both abrasion and punctures from backfilling. New tape requires a special primer. Can be applied by hand or by machine; is available in a wide range of thicknesses and widths.

CIRCLE (11) ON THE REPLY CARD

THREE TRAY STOCK CARTS designed for easy movement of bulky and package items are available from Bay Products Division. Carts are now available with a "trip saver" center tray for still greater loading. Up to 500 lb can be handled easily by one man and moved wherever there is a floor. Carts are available in either 16 by 30 in. size for narrow aisles or a 24 by 36 tray size for large loads.

CIRCLE (12) ON THE REPLY CARD

NEW Lancaster VALVE COVER
eliminates practically all troubles from normal sticking and lifting valves . . .
* Gum-resistant ring Specially compounded of friction-free inert carbon-graphite
* Large-Profile Stud offers greater contact area
New Lancaster Valve Cover has the most level and truly concentric seat surface ever achieved. Special compound of carbon-graphite is strong, shock resistant and silent . . . ends valve squeaks and is far less apt to break or chip in transit, repair or installation.
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keeps pans moving in straight line . . .
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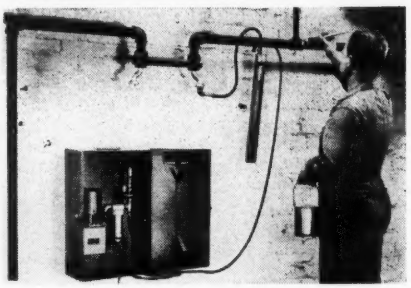
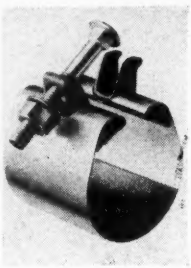
PRODUCT PARADE



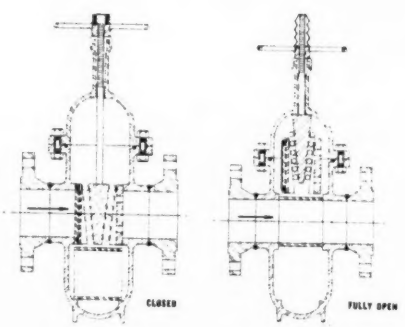
LEAK SEEKER for testing gas lines. New device which converts the tedious job of finding gas leaks into a 1-man instead of a 2-man job, is now available from The DeVilbiss Co. The device, a small electrically operated compressor, builds up and maintains a constant test pressure in low and intermediate pressure gas lines. It will pump lines up to test pressure faster — at least 8 times faster — than the quickest hand methods, and automatically holds the desired pressure indefinitely without attendance by an operator. Thus, one man can check entire job. Unit can be used to check out new installations or old, and for finding leaks wherever suspected. Self-contained, unit weighs only 24 lb; can be used on any of the type of manometers or gages now utilized for testing low or medium pressure lines.

CIRCLE (13) ON THE REPLY CARD

PIPE CLAMP recently patented by Adams Pipe Repair Products has several mechanical features that provide even distribution of pressure during tightening and insure the smooth functioning of the clamp without danger of crushing weak pipe. It is available for pipe diameters from ½ to 8-in., and in lengths from 3 to 12-in. Also obtainable on special order for pipe diameters up to 24-in. and in lengths up to 21 in.



CIRCLE (14) ON THE REPLY CARD



ANTI-FRICTION UNIT FOR GATE VALVES employing a self-sealing synthetic rubber seal gasket, is now being marketed by Charles Wheatley Company of Tulsa. New assembly assures higher working pressures, is drop tight, and eliminates need for mechanical operators. Unit consists of a tapered wedge assembly mounted on roller bearings that controls the movement of the valve discs. Unit is designed for sizes 2 through 30-in. standard and through conduit gate valves, for 0 through 10,000 psi working pressure at temperatures from –60 to 350 F.

CIRCLE (15) ON THE REPLY CARD

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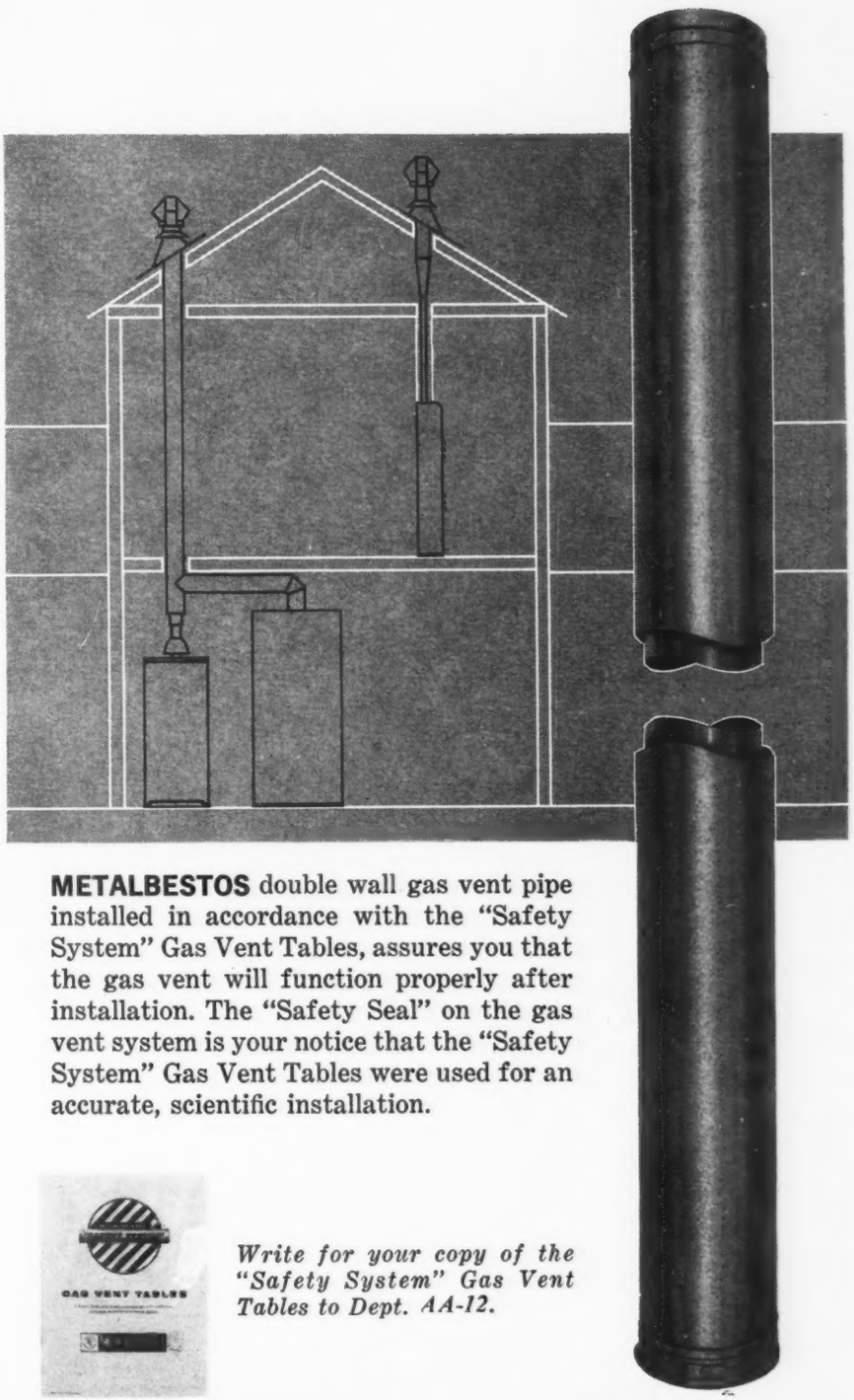

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BULLETIN BOARD

CATALOGS – BROCHURES – TECHNICAL DATA

TWO NEW 35mm FILM-STRIPS are available to help boost Gold Star range sales. Both films, created by DMCO Productions in Dallas, are in full color with professionally narrated recordings. The first, entitled "What's the Big Idea?", runs for 14 minutes and is aimed specifically at dealers, dealer's salesmen, and company sales staffs. Tells a story of higher profits and greater consumer acceptance through the Gold Star range program. The second film, labelled, "The Gold Star in Your Future," is directed to the retail customer. Also 14 minutes in length, it combines the light touch with real sales punch to describe Gold Star requirements for gas ranges. Films may be purchased individually or as a set.

CIRCLE (61) ON THE REPLY CARD

INTERNATIONAL TD-9 crawler tractor is featured in 16-page, 2-color catalog available from International Harvester Co. Features of the unit include 55.7 drawbar hp, a 5 roller track frame (with 4 rollers optional), a 5 forward-speed and 1 reverse-speed transmission (optional transmission of 4 forward speeds and 2 reverse), a 6-cylinder turbocharged 66 net hp diesel engine, pushbutton direct starting, and new 500-hr lubrication period track rollers.

CIRCLE (62) ON THE REPLY CARD

ADVANTAGES OF GAS-FIRED HYDRONIC HEAT with Hydrotherm boilers are listed in new 4-color folder from Hydrotherm, Inc. Folder is available to plumbing and heating contractors, architects, and builders for use as a selling tool. Folder is smartly designed, printed in full color, and written in clear, easy-to-understand terms. Mechanical and performance advantages are illustrated.

CIRCLE (63) ON THE REPLY CARD

RECOMMENDED PIPING PRACTICE, a handy wall chart suitable for posting on shop bulletin boards, has been published by Lunkenheimer Co. The 3-color, 17 x 22 in. chart is useful for installation and maintenance personnel and individuals requisitioning valves of all types. Chart is divided into 5 sections entitled Basic Valve Types, Connections Normally Used, Installation and Maintenance Tools, Installation, and Operation and Maintenance. Illustrations of items from Lunkenheimer's line of valves, engineering specialties, and lubricating devices appear on the back of the wall chart.

CIRCLE (64) ON THE REPLY CARD

NEW COMPILER FOR ELECTRONIC COMPUTER Royal McBee's Act I, a compiling routine and translator for the Royal Precision LGP-30 Electronic Computer, is described in new 18-page booklet. Programming with the new compiler can be learned in a single day. With its aid, any problem can be submitted to the computer in simple algebraic form. The compiler is fed into the LGP-30's 4096-word internal memory on punched tape, and translates problems to machine language automatically. It need not remain in the machine at compute time, thus preserving the entire memory for useful calculation. Act I is capable of compiling fixed or floating point programs. Programming time is greatly reduced, thus allowing faster computer solutions to engineering and management control problems.

CIRCLE (65) ON THE REPLY CARD

AMERICAN METER COMPANY'S new high capacity aluminumcase meter is described in new bulletin. Compact and light in weight, the AL-800 aluminumcase meter has ample capacity for medium sized commercial or industrial loads. Has a rated capacity of 800 cu ft per hr at ½-in. differential, and 1700 cu ft per hr at 2-in. differential with 0.64 specific gravity gas.

CIRCLE (66) ON THE REPLY CARD

TELEMETERING, MONITORING, AND REMOTE CONTROL system for gas distribution lines is described in new bulletin from Femco, Inc. The "TMC" system is a wired system which telemeters levels, flows and pressures, and monitors and remote controls valves, pressure regulators, and compressors between the operations center and other points in the distribution system. System is based on the Femco circuit scanner, a synchronous commutator using hermetically sealed reed switches instead of sliding contacts. Circuit is established by a clock-driven rotating arm on which is mounted a permanent magnet. System is compatible with both digital and pulse duration transmitters, with digital computers, and with all equipment normally used for the operation of valves, pressure regulators, compressors, etc., in gas distribution systems.

CIRCLE (67) ON THE REPLY CARD

KANO LABORATORIES has published two interesting bulletins — "Genius At Work" that combines humor with ideas and short cuts in working with metal; and "Products Review" that describes many of the Kano products and their uses. Among the products described are Kroil, a chemical solvent to free frozen bolts, screws, or bearings; Prox, a fast drying, clear, coating to protect metal surfaces from corrosion; Glit, a detergent solution for cleaning glass and plastic surfaces, and Ovenlube and Pyrolube for high temperature applications where lubricant oils carbonize and burn off.

CIRCLE (68) ON THE REPLY CARD

GRIFFIN PIPE DIVISION of Griffin Wheel Company has published a booklet, "Introducing Griffin Pipe," that describes the new Griffin 20-in. cast iron pressure pipe and the company's manufacturing facilities.

CIRCLE (69) ON THE REPLY CARD

GAS AIR CONDITIONER. Day & Night Manufacturing Co. has available on request a 3-color, 6-page consumer sales brochure on its recently introduced gas air conditioner, the Oasis. The new air-conditioner that has a cooling coil unit that can be added on to existing forced-air heating unit, or a fan-coil unit for use when installation is for an independent cooling system. Brochure includes complete product information and specifications, and a full page of graphic installation diagrams which clearly explain how air conditioning will fit in the home in conjunction with an existing heating system. Of particular interest is a page devoted to a simplified diagram and explanation of the operating principles of an absorption cooling system.

CIRCLE (70) ON THE REPLY CARD

WALL CHART TELLS HOW TO WELD CONNECTIONS. Simplified procedures for making permanent electrical connections to any copper or steel structure are described and pictured on a 2-color 16 by 22-in. wall chart available without cost from Burndy Corp. It shows how to use the ThermOweld process for making a broad range of dependable connections without an external power source. General instructions explain how to select a mold, prepare the cable, and make a solid weld. Specific instructions show how to weld end to end, T, and X cable connections, as well as connections to ground rods, steel surfaces and bus bars.

CIRCLE (71) ON THE REPLY CARD

SERIES OF CLEVER ORIGINAL CARTOONS, pointing up the importance of preventive tractor maintenance, is offered **free** to owners and operators of construction equipment. Printed in 4 colors on heavy paper, the 11 x 13-in. posters contain no advertising and are suitable for tacking on field shacks, shop walls, and bulletin boards, or framing for more permanent display. Featuring cartoon characters in typical job situations, the series sells proper tractor maintenance in a humorous, enjoyable manner and is keyed to seasonal problems.

CIRCLE (72) ON THE REPLY CARD

WELDING EQUIPMENT is featured in new 40-page manual now available from Smith Welding Equipment Corporation of Minneapolis. Arranged in 6 sections, manual includes charts and technical data on company's line of gas welding, cutting, and allied equipment. Illustrations show equipment in proper size relation. One section is devoted to flow capacity curves for company's line of gas pressure regulators.

CIRCLE (73) ON THE REPLY CARD

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